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OFF-SITE SURVEILLANCE FOR OPERATION NOUGAT

Southwestern Radiological Health Laboratory
Las Vegas, Nevada

24 April 1964

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OPERATION NOUGAT

FINAL REPORT

US PUBLIC HEALTH SERVICE
OFF-SITE RADIOLOGICAL
SAFETY ORGANIZATION

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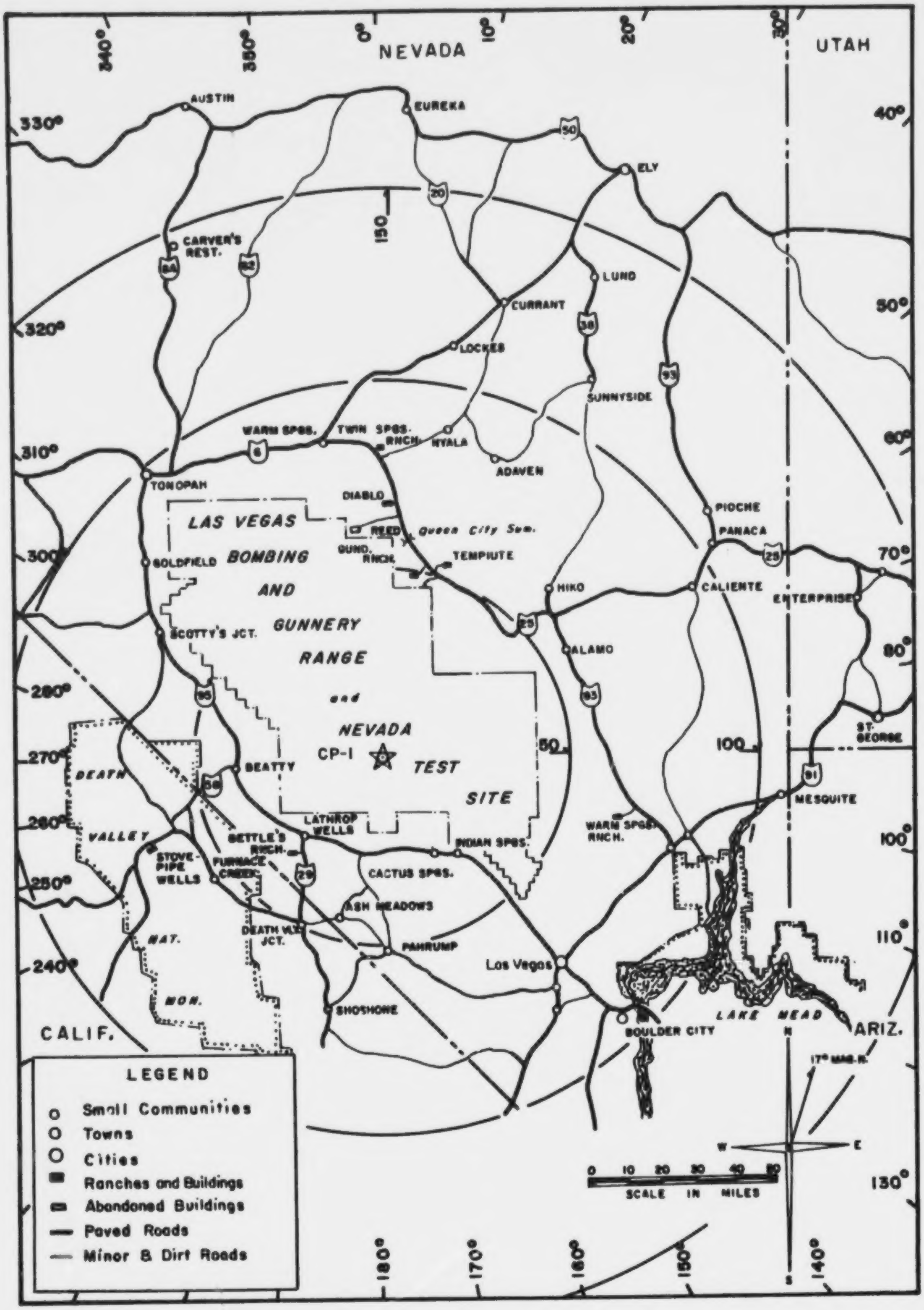
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Queen City Sum.
GUND. RNCH.
TEMPIUTE
PIOCHE
PANACA
GOLDFIELD
HIKO
CALIENTE
ENTERPRISE
SCOTTY'S JCT.
ALAMO
ST. GEORGE
LAS VEGAS BOMBING AND GUNNERY RANGE and NEVADA TEST SITE
CP-1
BEATTY
MESQUITE
LATHROP WELLS
WARM SPGS. RNCH.
DEATH VALLEY NAT. MON.
BETTLE'S RNCH.
INDIAN SPGS.
STOVE-PIPE WELLS
FURNACE CREEK
CACTUS SPGS.
ASH MEADOWS
DEATH V.L. JCT.
PAHRUMP
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SHOSHONE
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SCALE IN MILES
6
20
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8A
82
38
93
25
95
58
29
91
LEGEND
Small Communities
Towns
Cities
Ranches and Buildings
Abandoned Buildings
Paved Roads
Minor & Dirt Roads

Figure 1. The off-site area surrounding the Nevada Test Site and Las Vegas Bombing and Gunnery Range, showing azimuth and distance from CP-1.

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SWRHL-1r

FINAL REPORT
OF
OFF-SITE SURVEILLANCE FOR OPERATION NOUGAT
September 15, 1961 - June 30, 1962

by the
Off-Site Radiological Safety Program
Southwestern Radiological Health Laboratory
Las Vegas, Nevada

for
Division of Operational Safety
Nevada Operations Office
Atomic Energy Commission

April 24, 1964

Department of Health, Education, and Welfare
Public Health Service

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ABSTRACT

Operation Nougat was a series of forty-two announced tests of nuclear explosives conducted on the Nevada Test Site between September 15, 1961 and June 30, 1962. Seven of these tests released radioactive material to the atmosphere which was carried by prevailing winds into the public areas surrounding the test site.

This report concerns the program of off-site radiological surveillance conducted throughout Operation Nougat by the U.S. Public Health Service for the Atomic Energy Commission in accordance with a Memorandum of Understanding between the two agencies. The philosophy upon which the Off-Site Radiological Safety Program is based, the field and laboratory methods and equipment used, the measurements made, and the results obtained from off-site surveillance of the seven releases are described.

No cases of alleged radiation sickness or injury to people, livestock, or property were noticed by or brought to the attention of the Public Health Service during the Operation. The results of surveillance presented in this report indicate that the safety criteria established by the AEC for the off-site population were not exceeded during Operation Nougat.

FOREWORD

This report is concerned solely with activities of the U.S. Public Health Service Off-Site Radiological Safety Program. The Public Health Service conducts this program in accordance with Memorandum of Understanding No. SF 54 373, held with the Atomic Energy Commission, to fulfill its responsibility to the Commission and to the public to investigate, assess, record, and report the radiological situation in the public area surrounding the Nevada Test Site, and to inform and protect the public should an unacceptable radiological situation develop.

The report summarizes the off-site radiological safety activities carried out during Operation Nougat, a series of nuclear tests held at the Nevada Test Site from September 15, 1961 to June 30, 1962. It is to be considered the final report, and it supersedes all previous reports issued by the Program concerning events of the Nougat series. It was neither possible nor desirable to include in this final report every item of data collected. However, all data pertaining to exposure or contamination of people or of property in the off-site area has been included, and all other data are available in the Program's files in Las Vegas, Nevada.

Although every effort has been made to eliminate errors, it is virtually impossible to eliminate every mistake from a document containing so many individual items of data. If any abnormalities or errors, typographical or otherwise, are detected, it will be appreciated if they are called to the attention of the Off-Site Radiological Safety Program so that they may be checked against the original records.

ACKNOWLEDGMENTS

Responsibility and credit for the content of this document are shared by a number of people. Only those organizationally responsible for the work performed and reported can be specifically acknowledged here.

Mr. Oliver R. Placak, Officer in Charge, Southwestern Radiological Health Laboratory, was the Off-Site Radiological Safety Officer designated by the Atomic Energy Commission, Nevada Operations Office.

Mr. Morgan S. Seal served as Deputy Off-Site Radiological Safety Officer throughout Operation Nougat.

Program direction was provided by Mr. John R. McBride, Chief, Off Site Radiological Safety Program, with the assistance of Mr. John S. Coogan, Chief, AEC-PHS Special Projects, and Mr. Vernon E. Andrews, Chief, Off-Site Surveillance Section.

This report was originally compiled by Mr. David S. Groome, assisted by Messrs. Donald T. Wruble and George W. Niles.

Revision and edition of the final report was provided by Mrs.Geneva S. Douglas, Chief, Technical Reports Unit, with the guidance of Mr. Francis N. Buck, Special Assistant to the Officer in Charge.

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Chapter 1

HISTORY AND MISSION OF THE OFF-SITE RADIOLOGICAL SAFETY PROGRAM

In 1954, the U. S. Public Health Service (PHS) and the U. S. Atomic Energy Commission (AEC), by Memorandum of Understanding No. SF 54 373, agreed that the Public Health Service of the Department of Health, Education, and Welfare would operate a program of radiological surveillance and safety in the area surrounding the Commission's Nevada Test Site. Since that time, the Public Health Service has continuously conducted a program of comprehensive environmental sampling and radiation monitoring which is designed to document the radiological situation existing in the areas surrounding the Nevada Test Site and the Las Vegas Bombing and Gunnery Range. In addition, the PHS has maintained a public contact and information program to assure the public that all reasonable safeguards are being employed to protect public health and property from radiation hazard. The region in which these programs routinely operate is within approximately a 300 mile radius of the Nevada Test Site, and has been designated the "off-site area". (See Figure 1.) The total Public Health Service program of radiological surveillance and safety has thus been named the Off-Site Radiological Safety Program. Chapter 0524-05 "Off-Site Rad Safety Operations" of the Standard Operating Procedure - Nevada Test Site Organization (SOP-NTSO) [1] outlines in detail the responsibilities of the PHS to the NTSO and the procedures to be used in fulfilling these responsibilities. Although the objectives of the Off-Site Radiological Safety Program have changed little over the years, the organizational structure of the program and the procedures and techniques employed in its execution have undergone continual modification and improvement as experience and technological developments indicate changes to be made.

During the nuclear test moratorium which the USSR brought to a close on September 1, 1961, the PHS established, through its Division of Radiological Health, the Southwestern Radiological Health Laboratory (SWRHL) in Las Vegas, Nevada. A part of the SWRHL staff was permanently assigned to the Off-Site Radiological Safety Program, while the remaining staff members as well as the facilities of the entire laboratory were ready, whenever necessary, to suspend their routine work to supplement the Off-Site Program.

When the United States resumed nuclear testing activities with the

ANTLER Event of Operation Nougat on September 15, 1961, the Off-Site Program staff was increased from its interim period level by the addition of specially trained personnel of Civil Service and of the active and reserve Commissioned Corps. The resumption of testing also required an increase in the SWRHL program and staff so that by the end of Operation Nougat approximately 76 PHS personnel were on either active or standby assignment to the Off-Site Program. This total included 25 trained reserve officers who throughout Operation Nougat, were called to active duty in support of the program when periods of concentrated test activity required it.

Within the limits of feasibility, this report gives a complete account of the Off-Site Radiological Safety Program conducted by the PHS during Operation Nougat. The safety criteria, the operational procedures and the apparatus used to carry out the Public Relations, Surveillance, Medical, and Veterinary programs are described, and the information and data collected through these programs are presented and discussed.

Tables and figures which summarize the data or which may be of general interest are included in the body of the report. Tables of individual dose rate readings and tables showing concentrations of radioactive material in individual samples of air, water, and milk, or other environmental media have been placed in appendices to the report. Detailed tables of data showing background levels of radiation or absence of environmental contamination are not included. All data obtained during the series of events comprising Operation Nougat are, however, recorded in the files of the Off-Site Radiological Safety Organization in Las Vegas, Nevada, and will be made available upon request.

Chapter 2

PUBLIC RELATIONS PROGRAM

A less frequently mentioned, but very important part of the Off-Site Radiological Safety activities is the program of public education conducted to maintain public confidence that all reasonable safeguards are being employed to preserve public health and property from radiation hazard. This is carried out through liaison with state and local health officials and through personal contacts with residents of the off-site area.

Security regulations imposed for the Nougat series prohibited announcing a test before the actual detonation. Therefore, the PHS policy of informing state health officials of forthcoming events could not be continued as usual. However, state health officers in Nevada, Utah, Idaho, Arizona, and California were given as much information as security restrictions allowed as soon after a detonation as possible.

In carrying out their routine duties in the Off-Site area, whether or not testing is planned or in progress, Public Health Service personnel indicate to local residents their willingness to speak at civic or other public gatherings to explain the programs conducted at the Nevada Test Site and the role of the Off-Site Radiological Safety Organization. In some cases they actively solicit organizations to which talks may be presented.

Each presentation is tailored to the requirements of the group receiving it. A large proportion of the talks given during the Nougat series were to upper grade elementary and high school students. Lectures and films concerning elementary atomic physics and radiation effects were presented at most of the schools around the test site, and a large number of adult groups heard talks and saw films on nuclear testing and the safeguards employed to protect the public. Groups of farmers and ranchers in the area received more detailed explanations of these safeguards.

It has been found from past experience that perhaps the greatest contribution to good public relations can be made through individual personal contacts between PHS personnel and off-site residents. The practice of assigning monitors to specific areas or zones was partially reestablished during Operation Nougat. During this series monitors and their families did not establish temporary residence in their zones as they had done during past operations. However, each monitor traveled throughout his area extensively and frequently, and became acquainted with as many people as possible without forcing the acquaintance. The monitors maintained a friendly, open attitude toward these people much in the manner of good neighbors, and answered questions as freely as security restrictions allowed, frankly admitting it when they did not know the answer and offering to find it, rather than covering a lack of knowledge with evasion or the invocation of classification. In this way confidence in the monitors and in the Public Health Service and sincere interest in their work for the public welfare has been developed in residents of the off-site area.

In several ways a number of these people took part in the Off-Site Radiological Safety Program during Operation Nougat. All air sampling stations established in the off-site area for the duration of the Operation, with the exception of one in Las Vegas, were operated by local citizens. These people are instructed in the procedures for maintaining the samplers and for changing filters on a pre-determined schedule. They are given a supply of spare motors, filters, sample containers, and mailing envelopes, and they are paid a nominal fee to cover the cost of electricity and labor.

A still greater number of off-site residents wore film badge dosimeters which were changed periodically throughout the Operation by off-site monitors. Ranchers and farmers from whom milk and water samples were collected were told why the collections were made and how the analyses were performed. When analyses of these samples were completed the contributors were notified and the results and their significance were explained to them.

This program of personal contact is more time consuming than that of giving public talks and lectures, but the cooperation of local citizens greatly cuts the manpower required for surveillance and sampling activities. A more valuable benefit derives from the cooperation of local residents in that it gives them a sense of participating in the nuclear program, making them more vitally aware of the radiological surveillance in which the PHS is actively engaged for their safety.

This continuous, positive program of public relations paid off in producing general good will and understanding in the off-site population. Many budding complaints were stopped before they could become full grown, and throughout the Nougat series there were only a few short lived cases of hard feelings.

One incident occurred during the Operation in which this good will and understanding was tested. During the PLATTE Event of April 14, 1962, the AEC requested the PHS Off-Site Program to block traffic on Highway 25 north of the test site between its junction with the road to Nyala and its junction with Valley Road southeast of the first (see map in Figure 5.3.5). Roadblocks were set up at these points and all traffic was stopped until after PHS monitors had determined that the airborne radioactive material had passed without significant contamination of the highway.

After the northwest roadblock was established at 1140 hours, it was found that three ranch hands had earlier gone to work in an area just off Highway 25 within the bounds of the roadblock. A monitor sent to search for these men, intercepted them on Sand Springs Road about one mile northeast of its junction with Highway 25. When the reason for the interruption was explained, they accompanied the monitor to the nearest roadblock. They were surveyed with dose rate meters at this location since the levels of radioactivity along Sand Springs Road were above background. The clothing of the men was found to be only slightly contaminated, with the highest reading at any location well below permissible levels. Since no decontamination was required, the cloud had passed, and the men showed no anxiety over possible personal danger or radiation hazard, they were given the results of the survey and were allowed to go on about their business. The monitor who had intercepted the men then continued his monitoring duties. The film badge he wore throughout the day showed his total exposure to have been below the lower limit of detection (less than 30 milliroentgens).

This entire incident was handled smoothly with no problems arising then or later through public resistance, suspicion, or fear. The ease with which the situation was handled was due, at least in part, to the effectiveness of the Public Relations Program.

Chapter 3

MEDICAL AND VETERINARY PROGRAMS

The Public Health Service has been requested by the Atomic Energy Commission to include at least one Medical Officer on the staff of the Off-Site Radiological Safety Program. This Medical Officer is responsible for maintaining liaison with local physicians, answering inquiries on the medical effects of radiation, investigating all cases of alleged radiation injury, and conducting meetings for various groups who wish to know about biological effects of radiation. Before a test series, this Medical Officer usually visits all practicing physicians in the area to orient them on the work of the Off-Site Program. The visits also serve to brief the Medical Officer on the geographical nature of the off-site area and on the current local medical problems.

Although there was not time for a special series of visits to be made prior to Operation Nougat, local doctors were acquainted with the work of the Off-Site Radiological Safety Program through experience gained during previous operations and through occasional visits from an Off-Site Program physician made during the moratorium period. Throughout the Nougat series this liaison was maintained, and at the end of the series the Medical Officer contacted local doctors to indicate his continued availability for consultation should cases of alleged radiation sickness or injury arise. He received no notification of such cases, and none were brought to the attention of the Off-Site Radiological Safety Program during or after Operation Nougat.

The Public Health Service has also been requested to include the services of a veterinarian in its Off-Site Program capabilities. During Operation Nougat this capability was provided by the U. S. Army Veterinary Officer assigned to the Atomic Energy Commission's Nevada office through the Department of Defense. This Veterinary Officer visited ranchers and farmers in the off-site area to discuss matters pertaining to the health of local animals. In the course of these visits he let them know that veterinary diagnostic service would be provided and corrective action recommended if any problems arose which were felt to be a result of, or aggravated by, testing activities. During Operation Nougat no direct claims were made against the AEC for radiation damage to livestock, domestic animals, or wildlife.

With the assistance of the Veterinary Officer the Off-Site Radiological

Safety Program collected ecological samples from an area supporting a dairy herd in St. George, Utah. Samples of milk were taken weekly between October 29, 1961 and July 31, 1962. Water samples were taken over roughly the same period, and grass, grain, and fecal samples were collected monthly in March, April, and May.

Gamma pulse height analysis of milk was performed to determine the concentrations of iodine-131, cesium-137, barium-lanthanum-140, and potassium. Concentrations of strontium-89 and -90 and of stable calcium were also measured. Other samples were analyzed for five gamma-emitting isotopes as well as for strontium-89 and -90.

Only zirconium-niobium-95 and ruthenium-103 were found to be available to the St. George herd through the food chain. These isotopes, which were present in silage, hay, grass, and to a small extent in grain, usually pass through the animal without being metabolized to any significant extent. These isotopes were found in fecal samples but not in milk Strontium-89 and -90 were found to some extent in all samples but water. No radioactive materials above the detection limits were found in any of the eleven water samples collected. Cesium-137 and iodine-131 were not detected in food, water, or fecal samples although some milk samples contained amounts of iodine-131 well above the limit of detection. The highest concentration of iodine-131 in milk was found to be 95 picocuries per liter in one sample collected on February 21, 1962. Most of the isotopes found in milk were in amounts at, or just above, the detection limits of the analytical methods employed. The analytical results have been summarized in Table 3.1 and 3.2.

Table 3.1 Concentrations of various isotopes in samples of milk collected from St. George, Utah.

	gm/liter		pc/liter at time of collection				
DATE COLLECTED	Ca	K	Sr^{89}	Sr^{90}	I^{131}	Ba^{140}	Cs^{137}
			MILK				
1961 Oct 29	1.02	---	20	2	60	ND	10
Nov 4	---	---	---	---	50	ND	15
10	---	---	---	---	40	---	---
18	---	---	---	---	30	10	5
24	---	---	---	---	ND	ND	5
Dec 3	1.12	---	ND	3	ND	ND	ND
18	1.01	---	5	4	30	ND	10
18	1.22	---	ND	6	10	ND	ND
27	1.00	---	5	2	ND	ND	15
1962 Jan 3	1.02	---	10	2	ND	ND	ND
7	1.04	1.6	5	2	10	ND	ND
13	1.01	1.5	5	1	ND	ND	ND
21	1.00	---	ND	2	ND	15	10
27	1.00	---	5	2	ND	ND	5
Feb 3	1.12	1.5	5	2	20	ND	ND
21	1.07	1.7	ND	1	95	25	ND
Mar 4	1.01	1.7	5	2	ND	ND	ND
13	1.14	1.5	5	2	ND	ND	ND
19	1.08	1.5	5	3	10	ND	ND
26	1.11	1.5	ND	2	ND	ND	ND
Apr 2	1.02	1.4	ND	2	ND	ND	ND
9	1.08	1.6	ND	2	ND	ND	ND
16	1.14	1.4	10	3	ND	15	ND
30	1.12	1.5	20	1	ND	ND	ND
May 7	1.03	1.5	10	3	15	20	10
14	1.11	1.5	10	4	ND	ND	10
21	1.13	1.3	15	4	30	ND	ND
25	1.23	1.6	30	5	25	ND	30
Jun 4	1.09	1.5	30	5	20	20	30
10	---	1.4	---	---	ND	ND	15
17	---	1.4	---	---	ND	ND	20
24	---	1.4	---	---	ND	ND	20
Jul 4	---	1.3	---	---	ND	ND	15
9	1.05	1.6	25	5	20	40	50
16	---	1.8	---	---	20	30	50
31	1.06	1.8	25	6	40	10	35

Table 3.2 Concentrations of various isotopes in ecological samples collected at St. George, Utah.

DATE COLLECTED			pc/gm Ash Weight		pc/kg Fresh Weight	
			Sr^{89}	Sr^{90}	Zr^{95}	Ru^{103}
SILAGE						
1962	March	26	--	--	380	740
HAY						
1962	March	21	97	7.9	30,000	9,500
	April	18U	150	15	55,000	21,000
		18C	3.6	1.8	2,500	D
	May	22U	34	3.8	50,000	19,000
		22C	23	4.3	5,100	5,400
GRASS						
1962	March	21	120	7.2	22,000	5,100
	April	18	7.9	1.4	4,100	1,900
	May	22	11	1.9	8,900	3,500
GRAIN						
1962	March	21	--	1	ND	990
	April	18	--	--	ND	D
	May	22	3.9	6.5	ND	ND
FECES						
1962	March	21	--	--	1,600	480
	April	18	5.6	4.3	1,900	760
	May	22	56	8	7,500	1,700

U - uncovered; C - covered

Chapter 4

SURVEILLANCE PROGRAM

4.1 SAFETY CRITERIA

Throughout Operation Nougat the criteria used for determining the radiological hazard to the off-site population were those set by the Atomic Energy Commission after considering the recommendations of other authorities. The external whole-body exposure to gamma radiation could not result in a total dose greater than 3.9 roentgens per year and not more than 10 roentgens in any consecutive 10 year period. These values include any exposures from non-weapons test activities but exclude background and medical x-rays. The external exposure was that estimated from doses recorded by film badges worn by off-site residents, or from records of dose rate readings taken in populated areas by PHS monitors.

The maximum permissible concentrations of radioactivity in air and in water, milk, and foodstuffs were not to exceed one-tenth the permissible concentrations listed in NBS Handbook 69 [2], assuming these concentrations could be averaged over a period of one year. The concentrations of radioactivity in these media were determined from analysis of samples collected from the off-site area by the Surveillance Program. Data obtained through Surveillance Program activities during the series of tests which constitute Operation Nougat show that these maxima were not exceeded. At no time during the Operation was it necessary to evacuate a populated area or to isolate or cut off any supply of milk, water, or food.

4.2 COMMUNICATIONS

All field personnel in the off-site area worked from vehicles, usually pick-up trucks, equipped with two way radios operating on a very high frequency FM band. These vehicles were mobile stations in a communications network through which directive personnel at the Program headquarters in Building 155 at Mercury or at the NTS Control Point (CP-1), and laboratory personnel in all PHS buildings at Mercury and in Las Vegas, were in constant communication with each other and with the mobile surveillance teams. Radio traffic, which used an abbreviated form of the standard "Ten-Code", was coordinated and regulated through Net Control located in the radio room at CP-1. The aerial cloud tracking team used by the PHS was in radio contact with

Net Control, as was the U. S. Weather Bureau and other support groups. Thus, through Net Control there was a ready exchange of immediate information among the entire PHS radio network and all cooperating agencies.

4.3 FIELD PROCEDURES

The working field unit of the Surveillance Program was the vehicle-mounted "monitoring team" which was one or two people equipped with various survey instruments, sampling apparatus, tools and supplies. The fully equipped vehicle of a monitoring team is shown in Figure 4.1. Using dose rate meters or survey instruments, the monitoring teams surveyed roads, areas, and locations suspected of being within the cloud trajectory. They set up additional air sampling stations, fallout trays and dose rate recorders, augmented routinely operating stations with charcoal cartridge collectors, and collected other environmental samples when required. They noted the presence of people or farm animals in areas not usually inhabited, observed the condition of back roads and trails which might be needed for cloud tracking or surveillance routes, and checked infrequently traveled areas for radio reception and transmission. If evacuation of people or animals had become necessary, which it did not during the Nougat series, these teams would have performed the required operations, enlisting the assistance of local police or county sheriff departments when feasible. Working from directives and information received by radio, each team performed its surveillance duties and kept a running log of its activities from the time it was dispatched to its duty station several hours before a scheduled event until the time it reported back to headquarters at the end of its mission.

On his monitoring log each monitor recorded his name, the serial numbers of the survey instruments he used, each dose rate reading, and the exact time and location at which it was made. When the location could not be identified by a specific name, he recorded the direction and the distance indicated by his vehicle's odometer from a known reference point. On his log the monitor also described other observations made or duties performed during the course of his monitoring run. These monitoring logs provide an original record of surveillance activities and monitoring results and they are retained in the permanent files of the Off-Site Radiological Safety Program.

The dose rate readings taken by ground teams during each event of Operation Nougat which released radioactive material off site have been compiled into the tables found in Appendix A. The significance of the data recorded by monitors during these events is discussed in Chapter 5.

During Operation Nougat, the PHS for the first time used an aerial monitoring team to augment its surveillance program. Cloud tracking missions were carried out by a PHS monitoring team in military aircraft piloted by Air Force crews. These missions assisted ground monitors in locating and following the clouds, and worked throughout the Operation to develop and test instruments and procedures with which to define not only the cloud position and direction of travel, but also the distribution and magnitude of radioactivity contained within it. Before detonation of a device the cloud tracking aircraft flew in a standby pattern within sight of Ground Zero. After detonation, if no visible venting occurred, low altitude passes were made downwind of Ground Zero to determine if gaseous radioactive material could be detected. After collapse of the cavity, if no radiation had been detected by the aerial team, a ground telemetry indicated no release of radioactive material, the aerial monitoring mission was terminated.

When a release did occur, the aircraft made a series of passes at several altitudes beginning downwind of Ground Zero and moving gradually outward. In this way the team estimated the width and depth of the cloud and determined its direction and speed of travel. Measurements of radiation intensity were made to determine the distribution and magnitude of radioactive material within the cloud, and to define concentration gradients if possible. These cloud tracking missions were terminated when the cloud had dispersed or the activity it contained had dropped to levels too low for measurement, or when flying conditions necessitated termination of the flight.

Throughout each aerial cloud tracking mission the PHS aerial monitors were in radio contact with Net Control at CP-1. In this way they immediately made known to control personnel, and through them to ground monitors, all information which could be used to increase the effectiveness of the Surveillance Program. A constant verbal record of each mission was obtained through use of a portable tape recorder. These records were later transcribed and used in evaluating the surveillance provided for each event.

Releases from tunnel shots were tracked and monitored by a similar protocol. The information collected through aerial monitoring was used with ground monitoring data in determining cloud trajectory and dispersion. Specific data or dose rate readings obtained by the aerial teams are discussed in Chapter 5.

4.4 AERIAL MONITORING INSTRUMENTS

Two instrument systems were utilized for aerial cloud tracking. The first was a detector-recorder system designed and assembled by the Off-Site Radiological Safety Program's electronics group. The instrument consisted of a small transistorized amplifier through which gamma radiation detected by a Precision Model 111 "Scintillator" [3] could be recorded by an Esterline-Angus strip chart recorder. This scintillator was the same instrument as that used by ground monitoring teams and is described in Section 4.5 of this chapter.

The second system used for aerial cloud tracking was the Portable Aerial Survey Meter SBL-2, developed by Edgerton, Germeshausen, and Grier, Inc., and delivered to the PHS early in 1961. The system, described in Santa Barbara Laboratory Report No. S-20 [4], was a transistorized, battery operated, portable scintillation detector and recorder designed to measure gamma dose rate from 0.2 to 2000 milliroentgens per hour under a variety of environmental conditions. It is illustrated in Figure 4.2. The system could be used for either ground or aerial surveys since it would read gamma dose rate incident at the detector or, through three gain selections, would compensate for altitudes of 100, 300, and 500 feet above ground while also compensating for aircraft attenuation. The readout of measurements taken at these altitudes was equivalent to the dose rate existing one meter above the terrain. The gain selection which gave readout of incident dose rate was more applicable to the geometry of a radioactive cloud or a small-dimensioned ground source. The SBL-2 did not, however, compensate for attenuation of radiation by the aircraft when reading incident dose rate. Other survey instruments of the type used by ground monitoring teams were carried in the aircraft as back-up systems, and so that readings of several detectors could be compared.

Both the Precision "Scintillator" and the SBL-2 systems were thoroughly flight-tested over old Ground Zero areas on the Nevada Test Site. It was found that the SBL-2 required modification before it could be used effectively. Modification of three units was completed by EG&G in time for them to be used in PHS aerial cloud tracking missions throughout Operation Nougat.

After Operation Nougat the SBL-2 units used by the PHS were further modified by EG&G. The additional modification made these SBL-2 units very similar to the more recently designed SBL-2 Portable

Aerial Survey Meter described in EG&G Instruction Manual S-300-MN[5].

4.5 GROUND SURVEY INSTRUMENTS

Each ground monitoring team carried four types of survey instrument which allowed it to monitor up to 200 milliroentgens per hour (mr/hr) of beta plus gamma radiation and up to 50 roentgens per hour of gamma radiation alone. The first two instruments described below were used most frequently during Operation Nougat, and the last two were used as back-up instruments to provide additional reliability.

Beckman[6] Model MX-5

This instrument is a Geiger detector having a range of 0 to 20 mr/hr using three scale settings. Its external probe has a beta shield which slides over the probe's window, to allow measurement of dose rate from either gamma or beta plus gamma radiation.

Tracerlab[7] AN/PDR-T1B

The Tracerlab T1B is an air ionization chamber detector which measures dose rate from gamma radiation only. It has a range of 0 - 50,000 mr/hr in five multiplication settings for its meter readings of 0 - 5. Although its sensitivity to dose rates under 5 mr/hr is inadequate for monitoring low levels of activity, this makes the T1B an excellent instrument for use in higher radiation fields.

Precision[3] Model 111 Standard "Scintillator"

This instrument, manufactured by Precision Radiation Instruments, Inc., consists of an external probe containing a sodium iodide crystal with most of the electronic components, and a battery box to which the probe is connected by a cable. Its range is 0 - 5 mr/hr using a six position range selector with two rows of scale divisions of the meter. When the lowest range switch position is used, the major scale divisions of the meter are read as 0.005, 0.010, 0.015, 0.020, and 0.025 mr/hr. The highest position requires reading the second row of numbers which then indicate 1, 2, 3, 4, and 5 mr/hr. Thus, the "Scintillator" was used to detect very low level gamma radiation and to discriminate small changes in low gamma dose rates.

Eberline[8] Model E500-B

The E500-B has a range of 0-2000 mr/hr through use of a five position range selector and two halogen-filled GM tubes. The lower four range selections of 0.2 to 200 mr/hr utilize an external Anton 112 tube in a probe equipped with a removable beta shield. Thus dose rates of up to 200 mr/hr from beta plus gamma radiation can be measured. The highest range selector position utilizes an Anton 302 tube located within the instrument case to measure gamma dose rates up to 2000 mr/hr.

All four instruments allow only two numbers to be read from their meters. Thus, dose rate readings contain only two significant figures, and a reading of 250 mr/hr usually implies a dose rate between 240 and 260 mr/hr. Under the best conditions a monitor could sometimes estimate a third figure which would reduce the range in the above example to 245 - 255 mr/hr. These four survey meters are illustrated in Figures 4.3A through D.

No alpha monitoring instruments were required throughout the Nougat series, so they were not carried by monitoring teams. PAC-3G alpha survey meters[8], kept in the headquarters building at Mercury, were ready for use if needed.

Ground monitors were frequently measuring dose rates from airborne radioactive material which could reduce the reliability and accuracy of the survey instruments by contaminating them. For this reason monitors carried their instruments individually wrapped in thin plastic bags. Contamination was then easily removed from an instrument by removing and discarding the outermost bag.

Readings were usually taken with the detector at waist level, about three feet above the ground, and were made outside the monitor's vehicle at some distance from it. Occasionally, the reading was made directly above the surface of an object such as a plant. When this was done it was noted with the dose rate observed on the monitoring log.

To augment the ground surveys made with portable survey instruments by mobile monitoring teams, three types of stationary detector-reactor systems were used during Operation Nougat. No permanent network of dose rate recorders was established for the Operation. Instead, the systems were placed by monitoring teams in selected locations during events in which the added coverage was desired.

One such system consisted of the Beckman MX-5 survey instrument coupled to an Esterline-Angus clock-driven strip chart recorder. This system had the advantage of requiring no external power supply, and of having the length of its record limited only by the life of its batteries. One disadvantage was the difficulty of maintaining calibration, and another was the necessity of selecting one range setting of the MX-5 prior to cloud arrival. If the pre-selected range was too low for the radiation field encountered, the resulting record could be used only to determine cloud arrival time or duration of cloud passage. A totally unreadable record resulted when the pre-selected sensitivity covered too wide a range of dose rates.

Another dose rate recording system used during Operation Nougat was the Eberline RM-5[8] which operated on a 12V DC or 110V AC power supply. The maximum time interval over which a record could be made was 26 hours determined by the length and speed of its strip chart. The system utilized a Geiger tube detector and provided a sensitivity range of 0.01 to 100 mr/hr. Several of the units were modified to provide a range of 0.1 to 1000 mr/hr. A logarithmic strip chart gave this system the capability of recording clearly the fluctuations in low dose rates as well as peaks of high intensity radiation.

A third system was used on only two occasions during Operation Nougat. It was a Gelman Type RDR[9] strip-chart detector-recorder operating on 110 V AC. Its detector readout had a range of 0 - 100 mr/hr. Although this system is not pictured here, photographs of the two most frequently used detector-recorder systems are presented in Figures 4.4

and 4.5. Significant data obtained from dose rate records are discussed in Chapter 5.

4.6 FILM BADGE DOSIMETRY

Film badge dosimeters were used extensively during Operation Nougat to document external radiation exposure to thirty-four locations and approximately two hundred and forty residents of the off-site area. DuPont Type 556 film badge dosimeters, supplied and read by the Reynolds Electrical and Engineering Company (REECo) Radiation Safety group, were used exclusively. These badges contained two film components, the low range component #508 for exposures of 0.03 to 5.0 roentgens, and the high range component #834 for measuring dose from exposures of 3.0 to 1000 roentgens. All badges which showed no exposure were reported by REECo as less than 30 mr and were considered by the PHS to represent a maximum dose of 30 mr.

Badges worn by individuals could not usually be considered indicators of dose to other members of their families or to their homes. Most of the people were quite mobile, and without an unreasonable increase in Surveillance Program personnel it was not feasible to determine and record the whereabouts, at any specific time, of even a small portion of the 240 badged individuals. Instead, film badges were set up at reference stations close to the residences of eleven of the people who wore film badges. These stations consisted of five badges attached to a wire suspended three feet above the ground. The dose to each station was taken as the average of the doses recorded by the five badges it contained. The station dose could then be compared with the dose received over the same period by the person near whose home the reference station was located. Reasonable agreement between station and individual doses resulted at these eleven locations.

To measure cumulative exposure to other locations film badge stations were established at 34 additional sites. These, like the reference stations, consisted of five Type 556 badges attached to a wire suspended three feet from the ground. Occasionally the dose to these stations was not the average of five film badge exposures since film badges at unattended locations had a significant mortality rate. Some badges were destroyed or made unreadable by the occasional extreme heat of the spring months, and the strong sand-laden winds which arise frequently throughout the year in desert areas. Also it was found that badges color-coded with green tape or packaged in green plastic were apparently considered edible by wandering cattle and other herbivores.

Stations were repaired and film badges were exchanged at regular intervals by the PHS field personnel as part of their routine duties. All data from film badges worn by people or exposed at film badge stations have been tabulated and are presented in Appendix B with maps indicating film badge locations. Maximum doses from each type of exposure situation are discussed in Chapter 5.

4.7 ENVIRONMENTAL SAMPLING

Whereas dose rate monitoring and film badge dosimetry measure the external or exposure dose from radiation received by objects, people, or other living things, the internal exposure must be estimated by analyzing samples of the many elements of which their environment is composed. Thus, a surveillance program designed to evaluate the radiological safety of a population must analyze representative samples taken frequently from its environment.

During Operation Nougat samples of air, water, milk, vegetation and soil were taken from the off-site area. Air and, to a lesser extent, water were sampled regularly throughout most of the Operation. However, the other sample types were not taken on a routine schedule and were not truly representative of the environment, since they were usually single samples of relatively small volume taken as "grab" samples from areas known to be within the trajectory of the cloud arising from a particular event. Some samples given the general classification of water were samples from puddles and washes filled by a sudden rain, from drifts of melting snow, or from the edges of shallow ponds. One must therefore use caution in judging the significance of radioassay data obtained from them, and it must be emphasized that one cannot apply these specific data to make general inferences about the off-site environment or about the dose received by off-site residents.

4.7.1 Air Sampling

Continuous samples of air were taken by collecting airborne particulate material on Gelman[9] Type E glass fiber filters designed to be 99.6% efficient for collecting particles of diameters greater than 0.25 microns and 98% for 0.05 micron particles. These filters, held in commercially available filter heads fitted to High Volume Samplers, had an effective sampling area of 63 square inches. During Operation Nougat samplers made by Staplex Company[10] and General Metal Works[11] were used exclusively. These samplers used Electrolux motors and fans to draw air through the large filters at flow rates of 45-55 cfm ($1.3 - 1.6 M^3/m$). The throat of the motor housing of each sampler was machined to hold a 3-1/4" diameter activated charcoal cartridge made by Mine Safety Appliances Co.[12] With the MSA cartridge in place behind the filter, the normal air flow was between 20 and 30 cfm. Actual air flow was measured by inserting a rotameter in the orifice provided at the back of each unit. The samplers with or without the cartridge in place could be operated continuously over consecutive 24-hour periods without motor burn-out. Service consisted mainly of replacing motor brushes at regular intervals. A photograph of the air sampler assembly is shown in Figure 4.6.

Sixteen permanent air sampling stations were in operation at the beginning of the Nougat series. During the series this number was increased to 26. Additional air sampling stations were set up temporarily at selected locations during and after specific events. All locations from which air samples were taken at one time or another during Operation Nougat are shown on the map in Figure 1 of Appendix C.

Most samplers at permanently operated stations were tended by local residents who were paid a nominal fee to cover the cost of electricity and labor. These routine stations sampled only the particulates on the glass fiber filters which were changed once a day on a schedule convenient to the operator. After reading the rotameter and noting this reading and the date and time on a collection data sheet, the operator turned off the motor, and removed the filter sample, placing it in a glassine envelope with the completed data sheet. He then loaded the sampler with a clean filter, turned on the motor, took another rotameter reading, and noted the reading with time and date on a new collection data sheet. He was supplied with large pre-addressed manila envelopes in which to mail the samples to the Off-Site Radiological Safety Program laboratory for analysis.

The temporary sampling stations were set up by monitoring teams to operate from 3.5kw portable generators. Charcoal cartridges were used in addition to filters at these locations in order to collect gaseous material as well as particulates. During an event, the ground monitoring teams also inserted MSA cartridges in samplers at permanent stations located in the predicted cloud trajectory. The monitors then serviced these samplers until the cartridges were no longer required. Throughout these periods both cartridges and filters were delivered to the laboratory by monitoring teams as soon as possible after collection.

Breaks in the otherwise continuous air sampling coverage were due to motor failure, power failure, unusually bad weather, or failure to change the samples on schedule. Occasionally a sample was lost, or the date, time, or rotameter readings were not legible or not indicated. Efforts were made continually to eliminate the human errors and to minimize deficiencies due to factors beyond human control.

4.7.2 Water Sampling

Water samples were collected from a variety of sources throughout Operation Nougat. In general, permanent water supplies such as wells, springs and tap water were sampled every other month; and other sources such as ponds, creeks, puddles, and snow were sampled intermittently in conjunction with the increased surveillance provided for specific events. Samples were collected in polyethylene bottles by field personnel or monitoring teams. Reproducible sampling procedures were required if activity in samples from different sources was to be compared. Therefore, running water was collected whenever possible, and samples from ponds or puddles were taken from the surface in undisturbed areas close to the shore.

Varying volumes were obtained by this method, but further refinement of collection procedures was not feasible. As a result, 400 milliliters of sample were used for gross beta analysis, and gamma emitters were analyzed in either 400 ml or one gallon aliquots, depending on the volume collected.

4.7.3 Milk Sampling

With the exception of samples taken weekly from a farm in St. George, Utah in connection with the ecology study described in Chapter 3, milk was not sampled on a regular schedule during Operation Nougat. However, from November 1961 to June 1962 a total of forty-two milk samples was taken from ranches and dairies in the off-site area. These were usually one gallon samples of raw milk collected as part of the added surveillance provided for specific events.

The Processed Milk Monitoring Network of the Division of Radiological Health, PHS, was routinely collecting milk samples from Las Vegas, Nevada and Salt Lake City, Utah during the period of Operation Nougat. The collection procedures and analytical results have been reported in Volumes II and III of Radiological Health Data[13].

4.7.4 Vegetation and Soil Sampling

With the exception of the ecology study at St. George, Utah, no program of routine sampling of soil and vegetation was attempted during Operation Nougat, although a few samples of vegetation and of soil were collected in connection with specific events. No attempt was made to standardize the collection methods, and only qualitative analyses of these samples were performed. The nature of plants growing in the arid desert of the off-site area precludes any attempt to correlate activity in the plants with dose resulting in animals or man. It is difficult to take reproducible samples of the alkaline, hard-packed, coarse and dry soil found in many desert regions, and it is impossible to make general inferences from the data obtained.

4.8 SAMPLE ANALYSIS

During past operations, the Off-Site Radiological Safety Program had measured gross beta and gross alpha activity in environmental samples[14, 15, 16]. In 1958, milk samples collected during Operation Hardtack were analyzed for specific isotopes as well as for gross beta activity. Analytical methods were developed and improved during the moratorium period which followed, and late in 1959 the Off-Site Program obtained its first multi-channel pulse height analyzer. By the time the Nougat series began, the Program was equipped to make quantitative measurements of strontium-89 and -90 and a number of gamma emitters such as cesium-137, iodine-131, barium-140 and zirconium-95. By the end of Operation Nougat, methods had been developed and calibrations made for quantitative spectral analysis of nine gamma emitters as well as radiochemical analysis of several additional radioactive materials. The methods and equipment used to analyze environmental samples during the Nougat series are described briefly by sample type.

4.8.1 Air Samples

Gross beta counting of air filter samples was done with a large area (8" x 10") gas flow proportional probe connected to a high speed scaler to minimize dead time corrections. Efficiency for this system, based on a strontium-yttrium-90 standard of the same size, was approximately 30 percent. A photograph of this system using the Eberline[8] probe and an Ultrascaler [17] is shown in Figure 4.7.

Samples were held routinely for five days to allow decay of natural radioactivity prior to the first count. The second count was made seven days after the first, and a $T^{-1.2}$ extrapolation was applied to correct to mid-point or end of collection.

Filters collected for a specific event were counted as soon as possible, and then at frequent intervals thereafter, to obtain an empirical decay curve by which activity could be extrapolated to mid-point of collection. Since no mathematical model exists for decay of the fission product spectra escaping from underground detonations, this extrapolation was made graphically. Where indicated by the initial beta count, selected samples were submitted to gamma spectrum analysis for qualitative identification of gamma emitting isotopes. If the presence of fresh fission products was confirmed, these samples were scanned several times, and when feasible, an attempt was made to quantitate these isotopes by the decay pattern of various regions of the spectrum. Longer lived isotopes, or those for which standards were available, were quantitated by a matrix method which corrects for mutual interference between isotopes. If all else failed, the spectrum was smoothed under each photopeak and this portion was subtracted as a gross approximation of the background and scattering. Spectrum analysis of all filters was accomplished by folding the 8" x 10" filter paper in eighths and placing it directly on top of a 4" x 4" NaI(Tl) crystal[18] coupled to a multi-channel analyzer.

The same method of gamma spectrum analysis was applied to determine the type and quantity of gamma emitting isotopes collected in the charcoal cartridges. No holding period to allow for radon decay was required, and cartridges were analyzed as soon as possible after collection. The multi-channel pulse height analyzer assemblies and shields used during Operation Nougat are shown in Figures 4.8 through 4.10. Both 256- and 400- channel analyzers[19, 20] were coupled to 4" x 4" NAI(Tl) crystal detectors contained in massive steel shields.

Although geometry remained constant for spectral analysis of air filters and of charcoal cartridges, the volume of air collected varied greatly. Therefore, the minimum detectable concentration of a gamma emitter cannot be stated for air samples measured this way. In general, a total activity of less than 500 picocuries* for the shorter lived materials (Sr^{91}, Ru^{103}, Ru^{106}, Te^{132}, I^{132}, I^{133}, I^{135}, Xe^{135}) and of less than 100 pc for longer lived isotopes (I^{131}, Ba^{140}, Zr^{95}, Cs^{137}) could be detected but not quantitated.

4.8.2 Water Samples

Water samples were counted for gamma emitting isotopes in a one gallon inverted well beaker placed over the 4" x 4" crystal of an analyzer-detector system. If the sample was of insufficient size to permit this geometry, a 400 ml aliquot was placed in a "cottage cheese tub" container and centered on top of the crystal assembly.

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* one picocurie (pc) equals 2.2 disintegrations per minute

Approximate efficiencies for the two methods were:

Container	Energy	Efficiency
Beaker	0.36 mev	6.5%
	1.6 mev	2.4%
Cheese tub	0.36 mev	7.2%
	1.6 mev	2.3%

Quantitative determination of the gamma emitting isotopes followed the procedure used for analysis of air samples.

All water samples were analyzed for gross beta activity by slowly evaporating an aliquot to dryness in a 2" diameter stainless steel planchet and counting the beta activity in a low background counter. The results obtained were used in conjunction with gamma results to determine whether radiochemical analysis of strontium isotopes was warranted.

4.8.3 Milk Samples

One gallon samples of milk were placed in the aluminum beakers having inverted well geometry and were analyzed for gamma emitters by the matrix method. This permitted simultaneous analysis for iodine-131, barium-140, cesium-137, and potassium-40. When required, chemical separation of the strontium isotopes was made along with chemical determination of stable calcium. The total strontium was counted in a low background beta counter, as was the yttrium-90 daughter of strontium-90. Detection efficiency ranged from 33% for strontium-90 to 37% for yttrium-90. Strontium-89 was determined by difference between total strontium and strontium-90 as calculated from the equilibrium value of its yttrium daughter. These procedures resulted in the following detection limits for samples of milk or water:

strontium-89	5 pc/L
strontium-90	1 pc/l.
iodine-131	10 pc/l.
barium-140	10 pc/l.
cesium-137	5 pc/l.
zirconium-95	20 pc/l.

4.8.4 Vegetation and Soil Samples

Occasionally soil samples were subjected to gamma spectrum analysis for the purpose of evaluating gross surface contamination. Difficulties inherent in collection limited the usefulness of these data, and no attempt was made to make this a routine sampling program.

Vegetation samples were ground and placed in plastic "cottage cheese tubs" for gamma spectral analysis, which was normally qualitative for fresh fission products. Quantitative estimates were made only to indicate order of magnitude.

4.9 REPORTING

Surveillance Program activities and findings were reported to the Test Manager, Nevada Test Site Organization, NVOO, at frequent intervals throughout Operation Nougat. Reports fell into two general classes; reports of routine surveillance activities, and reports of additional surveillance performed in support of specific events. The latter were called "shot" reports. The former were called "monthly" reports since each covered the work done during a one month period. They reported data obtained from routine sampling of air, milk, and water, and showed the concentrations of radioactivity found in each sample as well as the concentration at each sampling location averaged over the entire month.

Shot reports were made in one to three stages. If no activity was released from an underground detonation, only one report was written to state that off-site coverage was provided and no radioactivity was detected. When there was a release of activity, a verbal report was made six hours after detonation, and a written report listing preliminary findings and data was submitted 48 hours after detonation. Approximately three weeks after the shot, an interim shot report was submitted. This interim report contained a complete description of the surveillance performed, the data obtained from monitoring and from sampling, and a tentative evaluation of the results. Occasionally, supplementary reports were made to transmit data or findings which were not available at the time the interim shot report was submitted.

All these reports, which were for official use only, are on file with the Nevada Operations Office, AEC, and with the Off-Site Radiological Safety Program, PHS, in Las Vegas. The present final report is essentially a compilation of the routine monthly reports and the shot reports issued during the Nougat series.

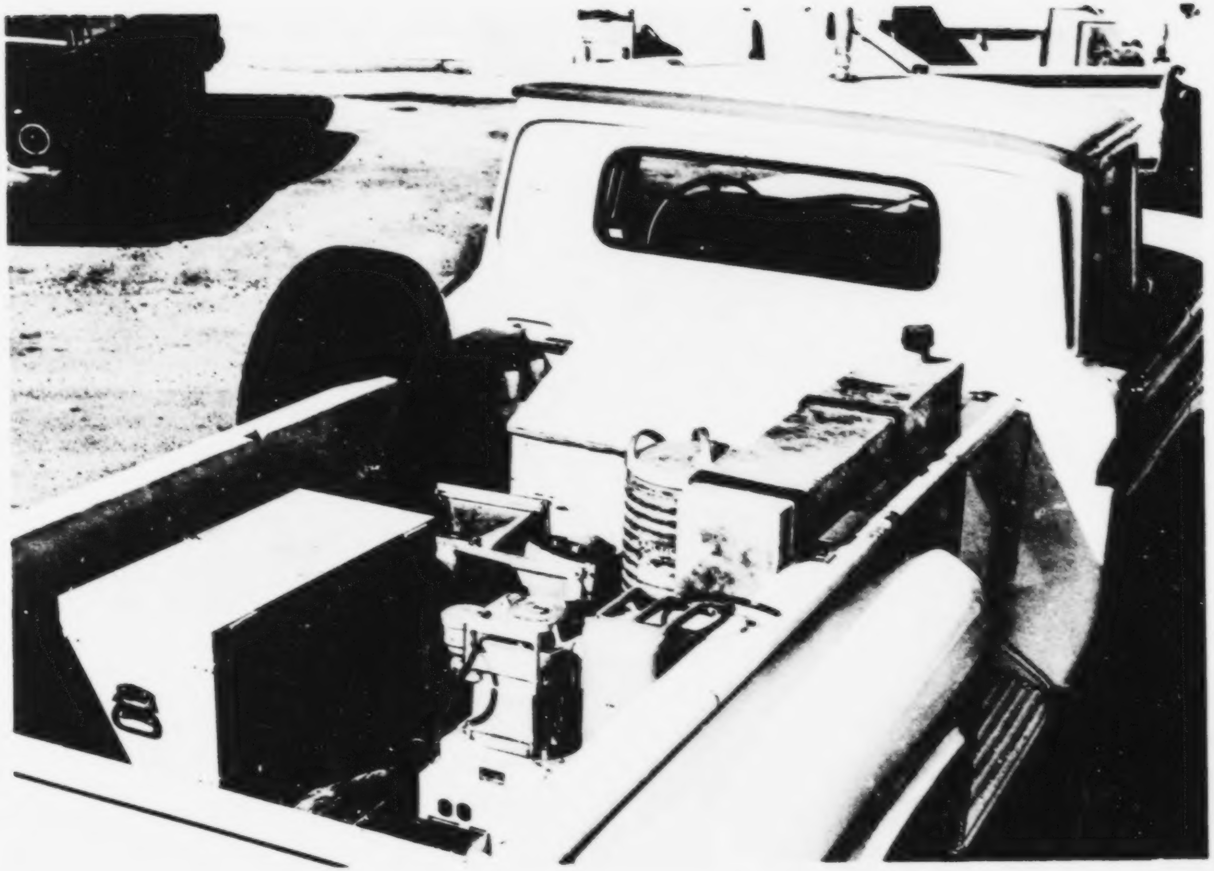

Figure 4.1. Vehicle equipped for use by an off-site monitoring team.

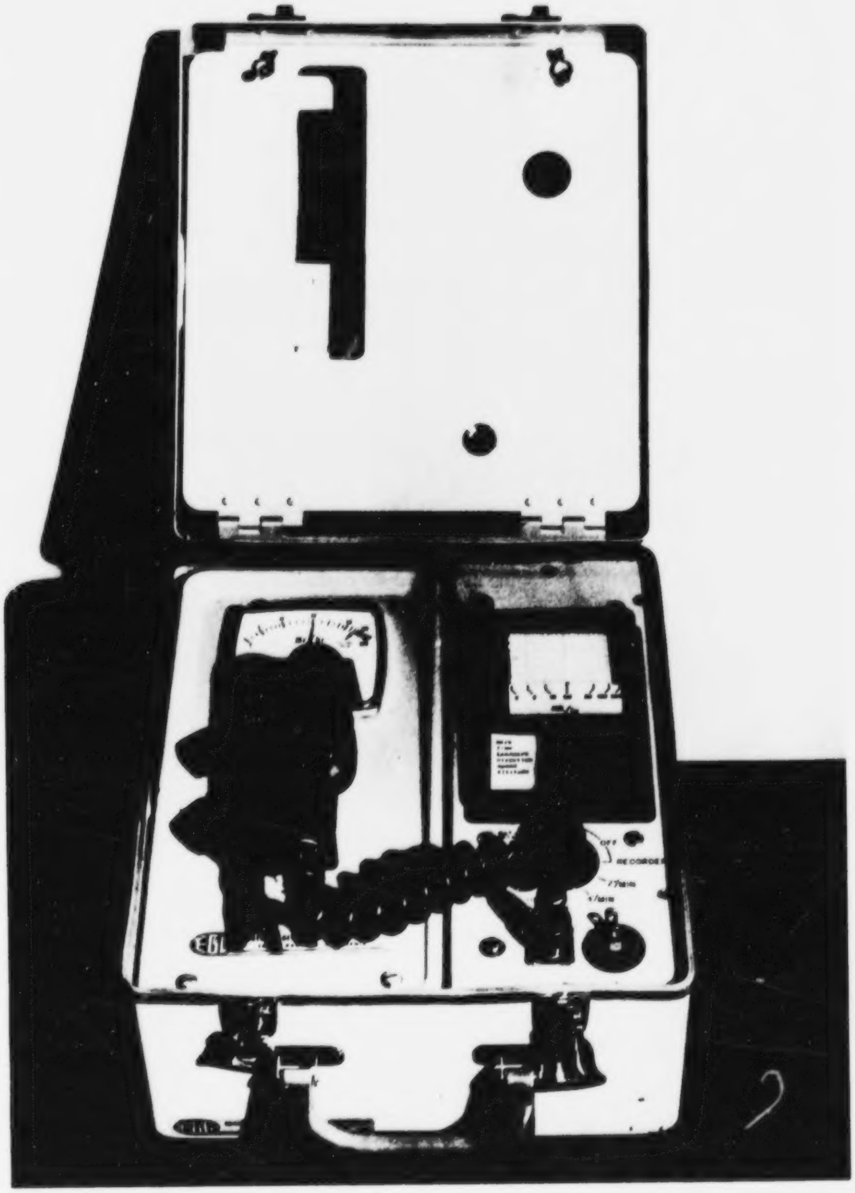

Figure 4.2. The EG&G Portable Aerial Survey Meter SBL-2 used for aerial monitoring during Operation Nougat.

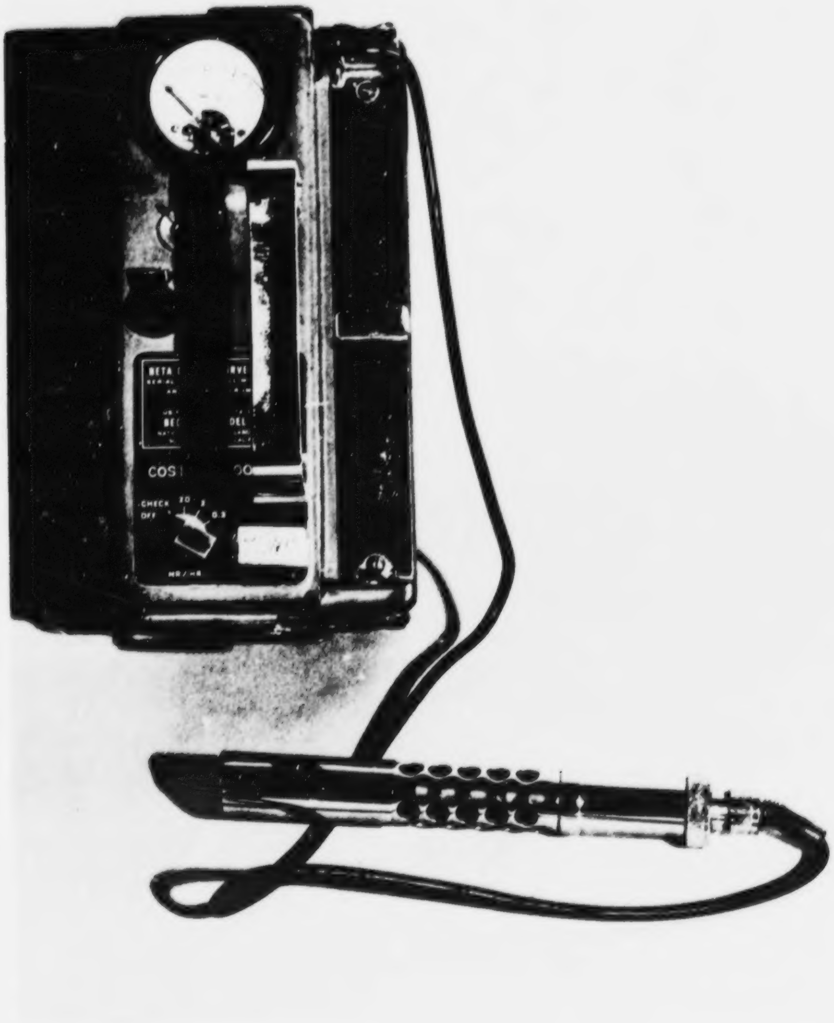
CHECK
OFF
20
2
0.2
MR/HR

Figure 4.3.A. Beckman MX-5 Portable Survey Instrument.

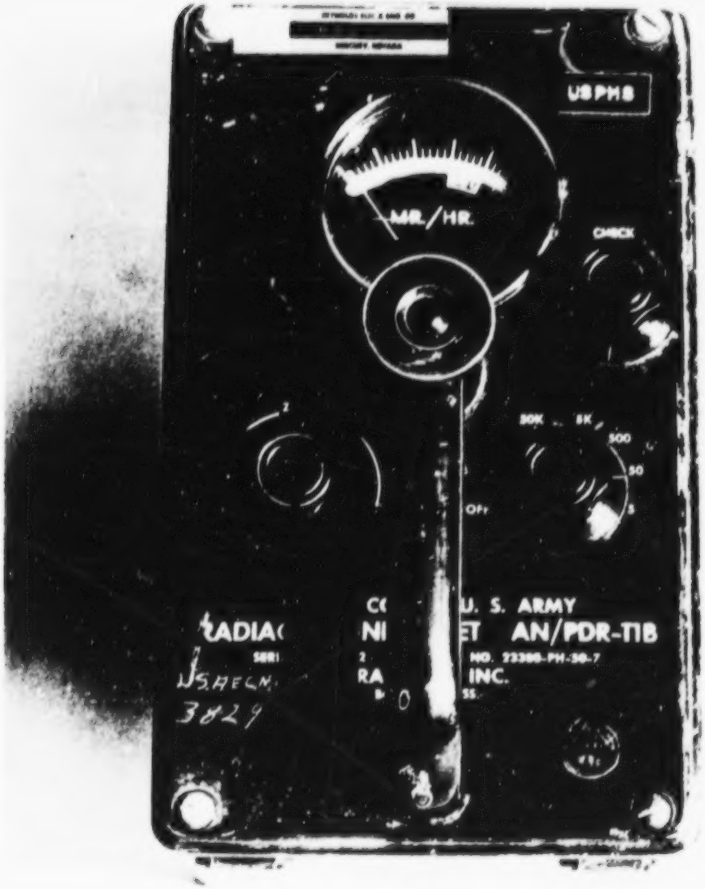
USPHS
MR./HR.
CHECK
OFF
50K
5K
500
50
5
U. S. ARMY
AN/PDR-T1B
INC.
U.S.AEC-N.
3829

Figure 4.3.B. Tracerlab AN/PDR-T1B Portable Survey Instrument.

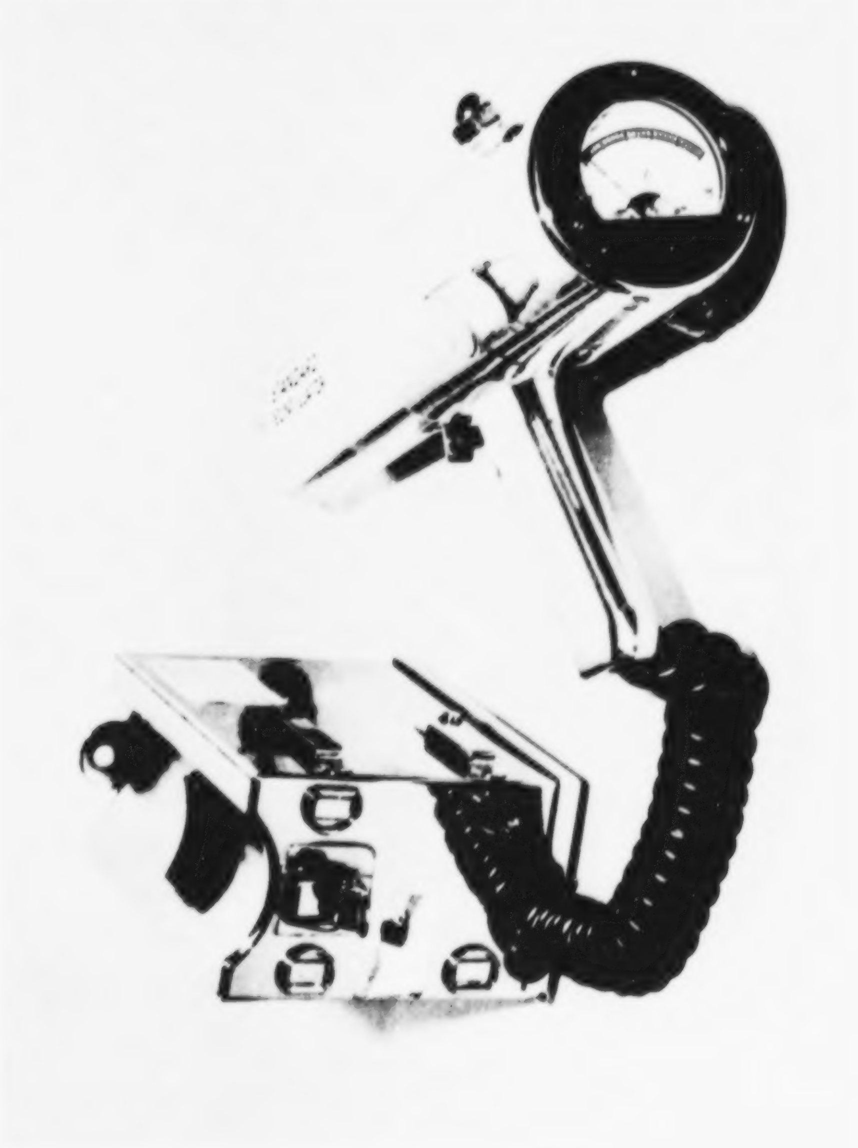

Figure 4.3.C. Precision Model 111 Standard "Scintillator" Portable Survey Instrument.

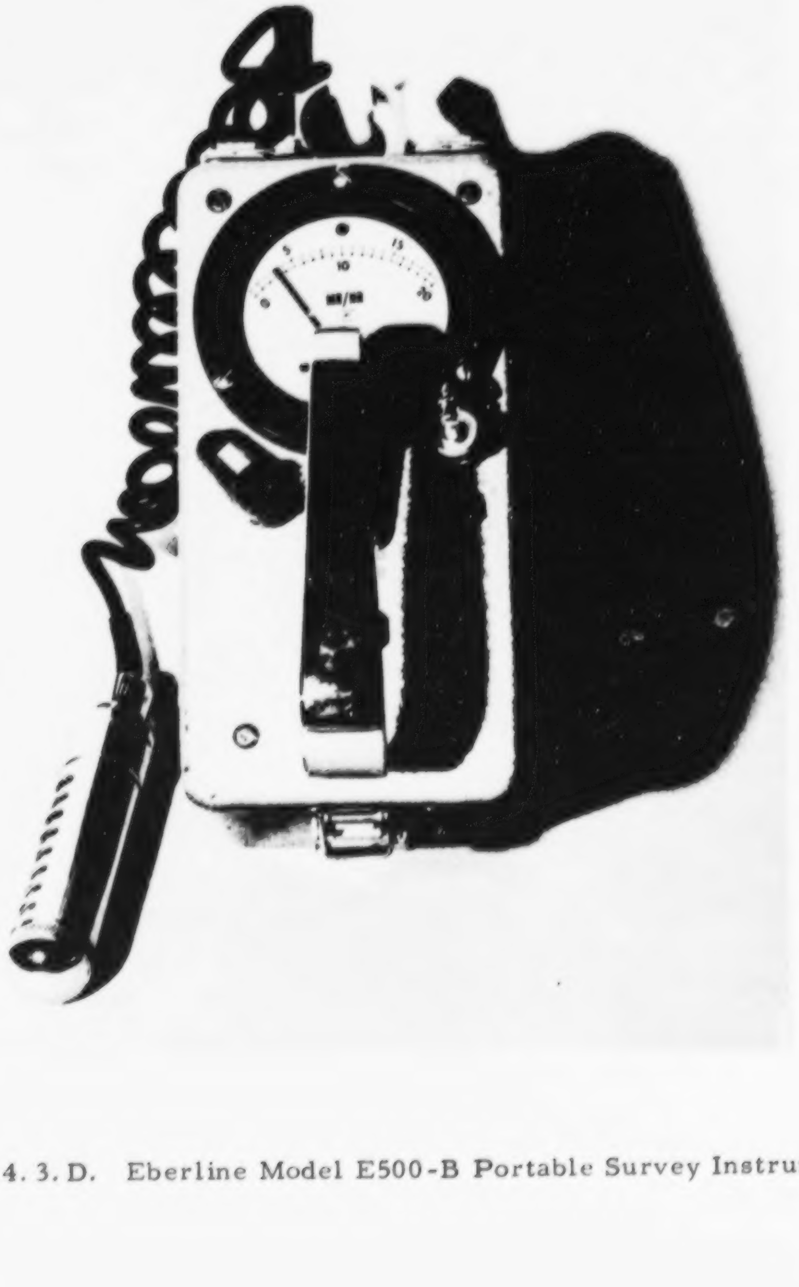

Figure 4.3.D. Eberline Model E500-B Portable Survey Instrument.

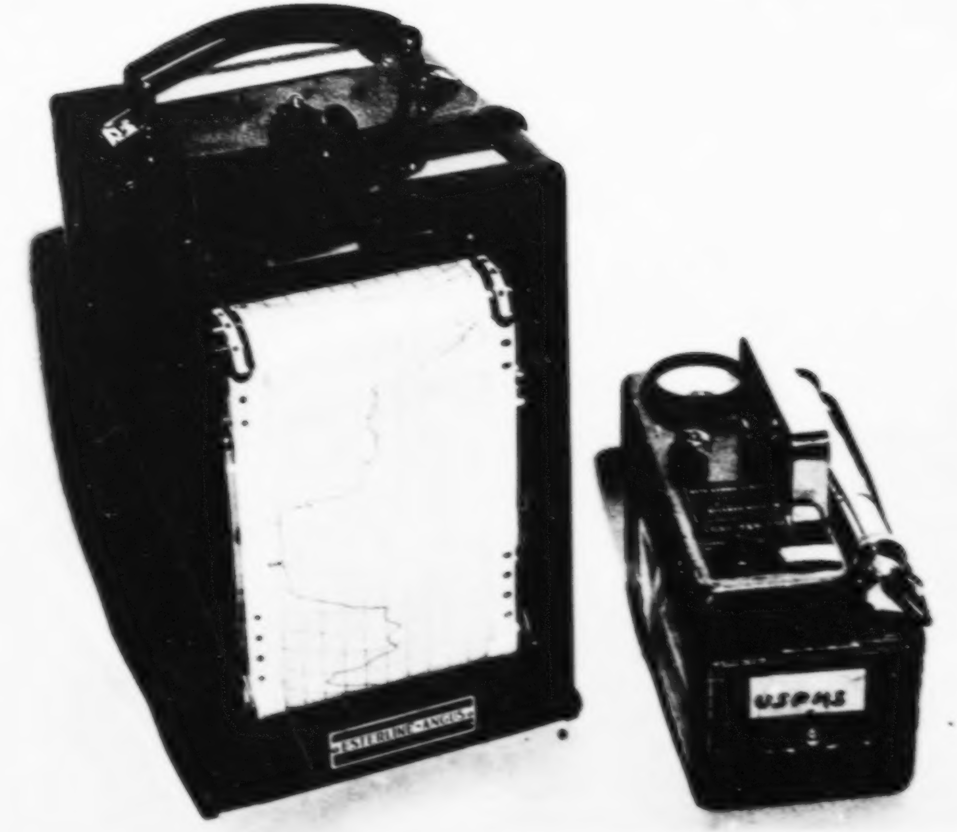
ESTERLINE-ANGUS
USPHS

Figure 4.4. Esterline-Angus recorder with Beckman MX-5 detector set up as a dose rate recording system.

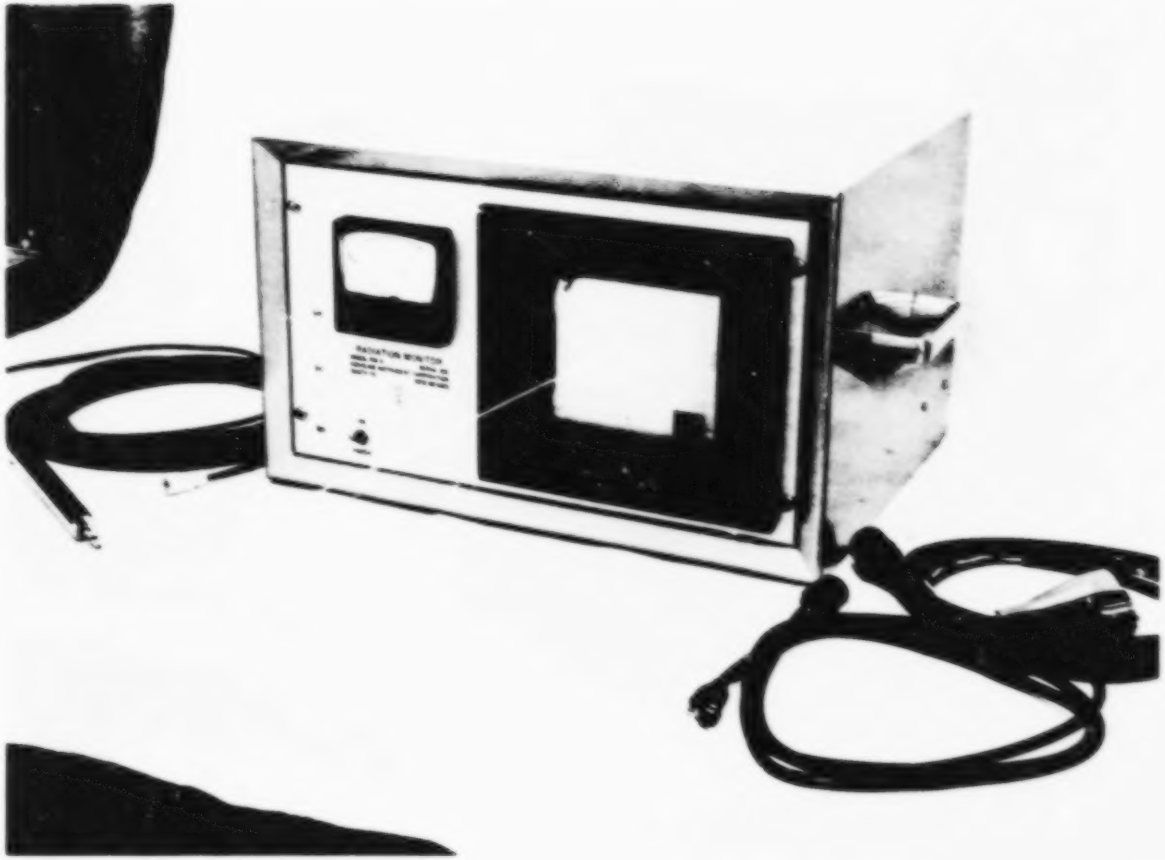
RADIATION MONITOR

Figure 4.5. Eberline Radiation Monitor Model RM-5 used as a dose rate recording system.

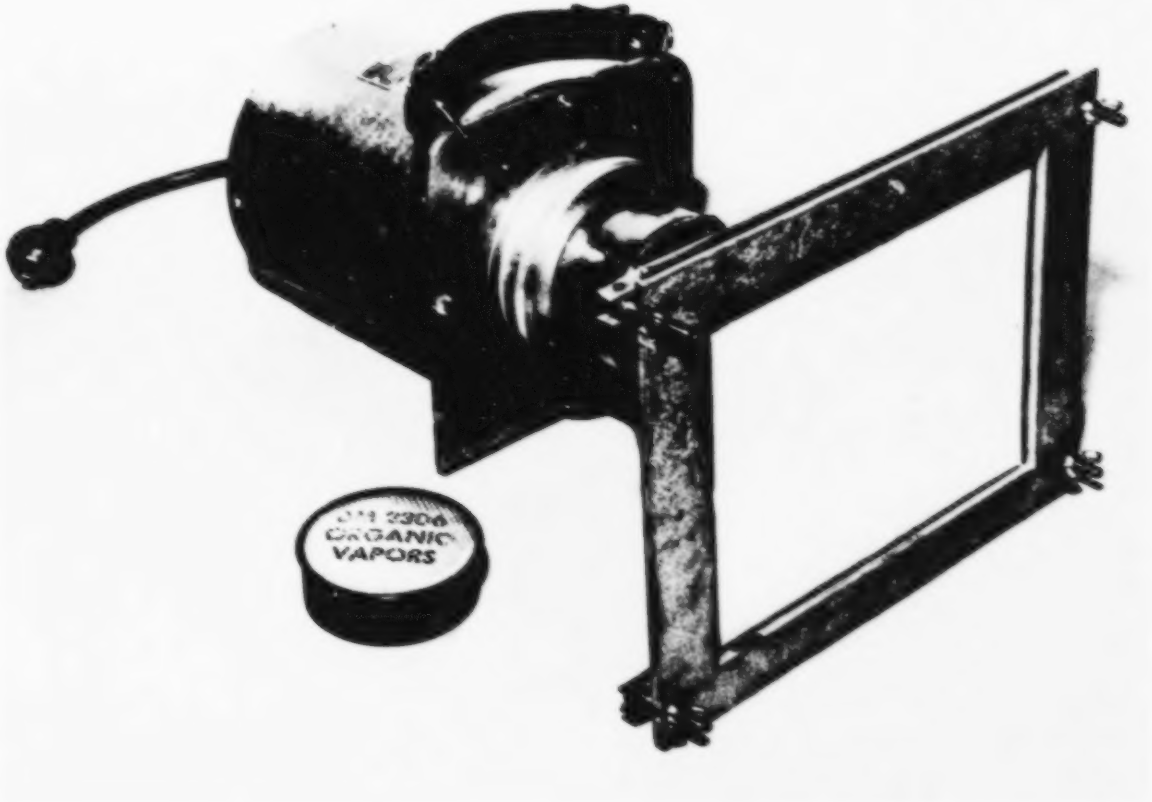
ORGANIC
VAPORS

Figure 4.6. High Volume Air Sampler with glass fiber filter in place, and with MSA charcoal cartridge shown beside the sampler.

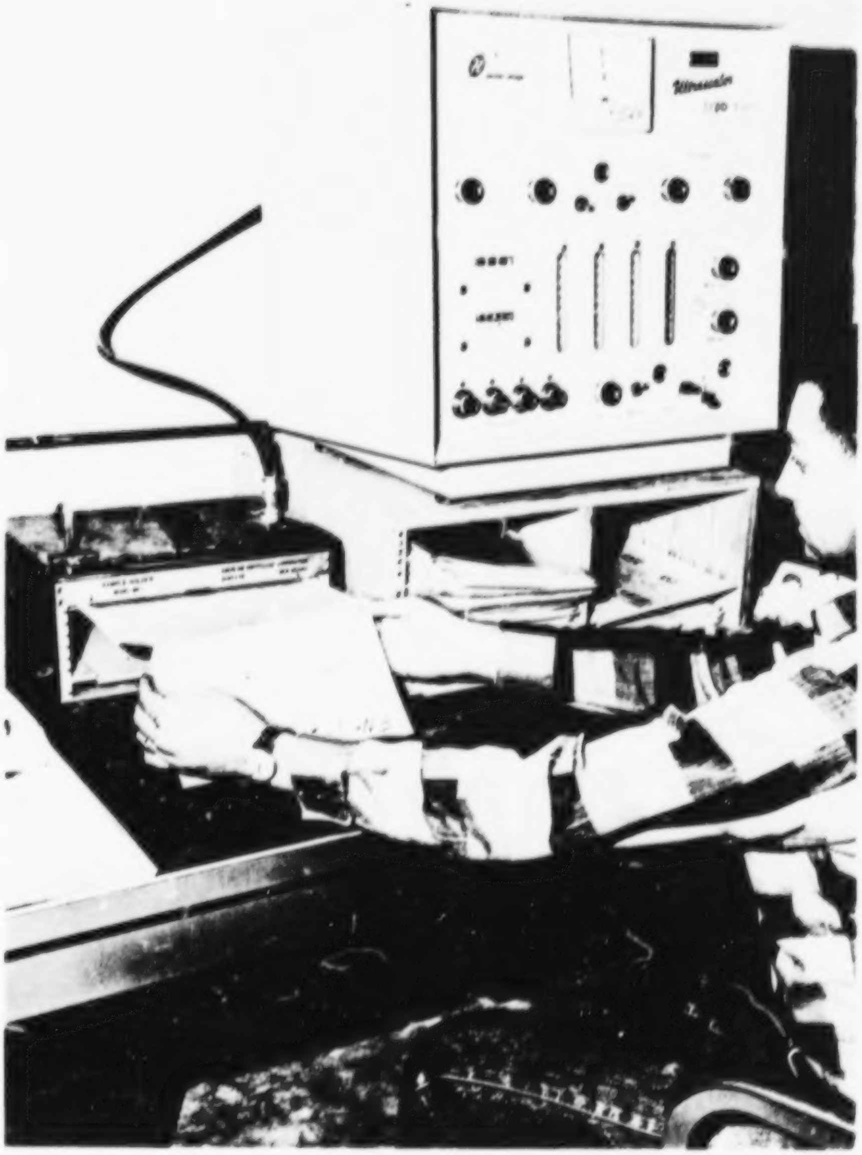

Figure 4.7. Counting gross beta activity on air filter samples using the wide area probe and Ultrascaler.

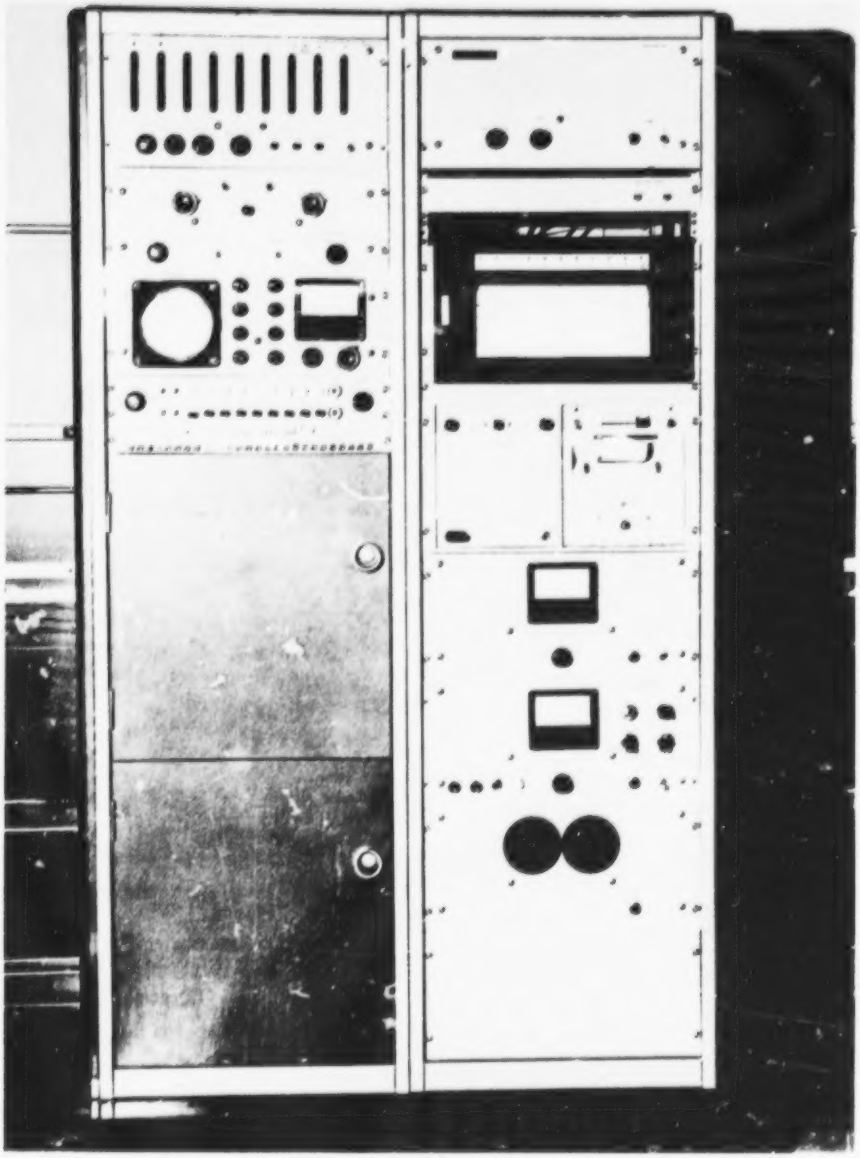

Figure 4.8. Radiation Counter Laboratory 256-channel pulse height analyzer.

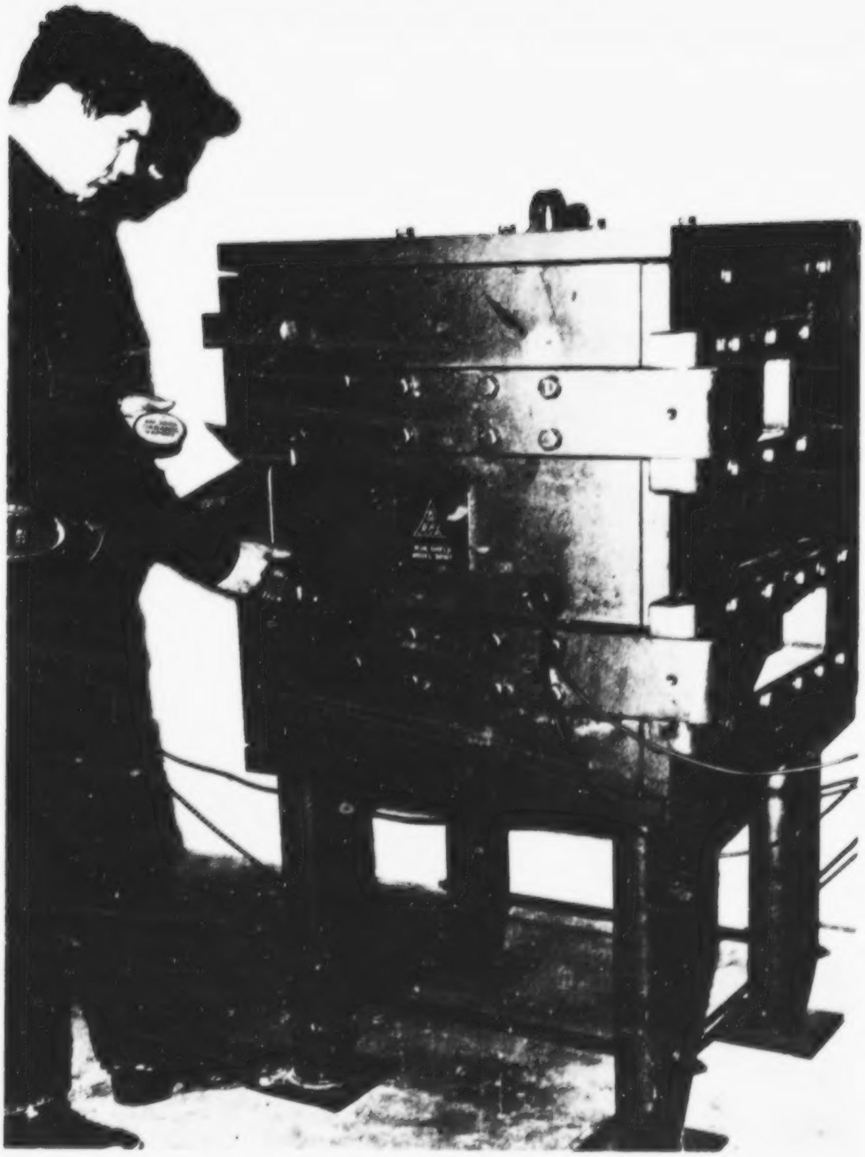

Figure 4.9. Single chamber shield containing a 4" x 4" NaI(Tl) detector.

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best available copy.

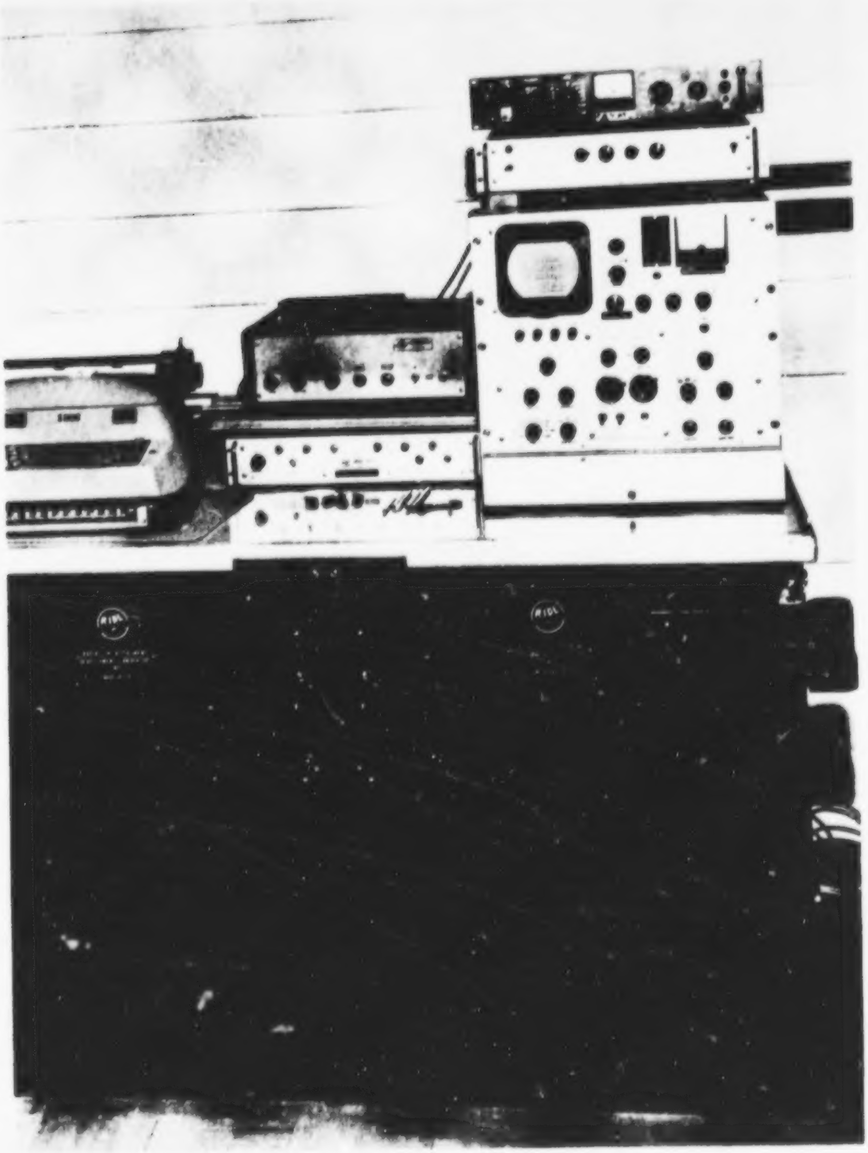


Figure 4.10. RIDL transistorized 400-channel pulse height analyzer with double chamber shield.

Chapter 5

SUMMARY AND DISCUSSION OF RESULTS AND DATA

5.1 DESCRIPTION OF OPERATION NOUGAT

As mentioned before, Operation Nougat consisted of a series of forty-two nuclear detonations announced by the Atomic Energy Commission as being conducted at the Nevada Test Site between September 15, 1961, and June 30, 1962. All these detonations took place underground, six of them in tunnels and thirty-six in wells.[21] Table 5.1 lists and describes the events of Operation Nougat, showing the date, time and location of each detonation as well as the laboratory or group by which each device was tested.

All devices were detonated only under conditions that would minimize exposures to populated off-site areas. One of the events was a cratering test (Danny Boy), and it was expected to release some activity to the atmosphere. Of the remaining forty-one events, only six released radioactivity detectable in the area off the Nevada Test Site and the

Table 5.1 Nuclear events of Operation Nougat, 9-15-61 to 6-30-62

No.	Event	Type	Area	Lab	Date	Time
1	Antler	Tunnel	12	LRL	09-15-61	1000-PDT
2	Shrew	Well	3	LASL	09-16-61	1445-PST
3	Chena	Tunnel	12	LRL	10-10-61	1000-PST
4	Mink	Well	3	LASL	10-29-61	1030-PST
5	Fisher	Well	3	LASL	12-03-61	1504-PST
6	Mad	Well	9	LRL	12-13-61	1000-PST
7	Ringtail	Well	3	LASL	12-17-61	0835-PST
8	Feather	Tunnel	12	LRL	12-22-61	0830-PST
9	Stoat	Well	3	LASL	01-09-62	0830-PST
10	Agouti	Well	3	LASL	01-18-62	1000-PST
11	Dormouse	Well	3	LASL	01-30-62	1000-PST
12	Stillwater	Well	9	LRL	02-08-62	1000-PST
13	Armadillo	Well	3	LASL	02-09-62	0830-PST
14	Hard Hat	Well	15	LRL-DOD	02-15-62	1000-PST
15	Chinchilla	Well	3	LASL	02-19-62	0830-PST
16	Codsaw	Well	9	LRL	02-19-62	0950-PST
17	Cimarron	Well	9	LRL	02-23-62	1000-PST
18	Platypus	Well	3	LASL-UK	02-24-62	0830-PST
19	Pampas	Well	3	LASL	03-01-62	1110-PST
20	Danny Boy	Well	18	DOD	03-05-62	1015-PST
21	Ermine	Well	3	LASL	03-06-62	0830-PST
22	Brazos	Well	9	LRL	03-08-62	1000-PST
23	Hognose	Well	3	LASL	03-15-62	0844-PST
24	Hoosic	Well	9	LRL	03-28-62	1000-PST
25	Chinchilla II	Well	3	LASL	03-31-62	1000-PST
26	Dormouse II	Well	3	LASL	04-05-62	1000-PST
27	Passaic	Well	9	LRL	04-06-62	1000-PST
28	Hudson	Well	9	LRL	04-12-62	1000-PST
29	Platte	Tunnel	14	LRL	04-14-62	1000-PST
30	Dead	Well	9	LRL	04-21-62	1040-PST
31	Black	Well	9	LRL	04-27-62	1021-PST
32	Paca	Well	3	LASL	05-07-62	1233-PDT
33	Aardvark	Well	3	LASL	05-11-62	1200-PDT
34	Eel	Well	9	LRL	05-19-62	0800-PDT
35	White	Well	9	LRL	05-25-62	0800-PDT
36	Raccoon	Well	3	LASL	06-01-62	1000-PDT
37	Packrat	Well	3	LASL	06-06-62	1000-PDT
38	Des Moines	Tunnel	12	LRL	06-13-62	1400-PDT
39	Daman I	Well	3	LASL	06-21-62	1000-PDT
40	Haymaker	Well	3	LASL	06-27-62	1100-PDT
41	Marshmallow	Tunnel	16	LRL	06-28-62	1000-PDT
42	Sacramento	Well	9	LRL	06-30-62	1430-PDT

adjoining Las Vegas Bombing and Gunnery Range (See Figure 1.). For simplicity this restricted area will be referred to as the Nevada Test Site for the remainder of this report.

Surveillance conducted for the Chena and Stoat events showed very slight indications of radioactivity at a few close-in off-site locations. For instance, during Stoat, the only survey meter readings showing dose rates above the normal background of 0.02 mr/hr were four readings of 0.01 mr/hr above background taken between 1233 and 1238 hours on a small segment of Highway 95 from 0.8 to 4.2 miles east of Lathrop Wells, about 33 miles from Ground Zero. All readings taken in this vicinity before and after this five minute period were at background, and no activity above background levels was detected on any air sample collected during the Stoat event.

Because off-site levels were so low, and because measurements were being made in the presence of activity originating from USSR atmospheric tests, it was not possible to positively identify any off-site activity as originating from Chena or from Stoat. These two tests are therefore considered to be among those which did not release activity to the off-site area[21]. Thus, only seven events, or one sixth of the total, released detectable activity outside the boundaries of the test site.

5.2 SUMMARY OF SURVEILLANCE PROVIDED AND RESULTS OBTAINED

The type and extent of surveillance provided by the Off-Site Radiological Safety Program for events of Operation Nougat have been indicated in Chapter 4 and are reflected in the tables provided in the Appendices to this report. This section gives a brief resume of the coverage provided for the seven events in which activity was released to the off-site area.

Table 5.2.1 presents a thumbnail sketch of coverage provided and results obtained from surveillance of each of the seven events. For both aerial and ground monitoring, the mission duration is given as the total time in hours and minutes that monitoring was conducted on the day of the event. The end of the mission is noted in hours and minutes after H-hour, i.e., H + 4:15 for Antler means the aerial monitoring mission terminated four hours and fifteen minutes after the detonation. When remonitoring of some areas was performed on the day or days following the event, an asterisk is shown after the time the monitoring mission ended.

Table 5.2.2 lists the locations at which air samplers and/or dose rate recorders were in operation during the seven events. These stations

Table 5.2.1 Summary of coverage provided and results obtained from off-site surveillance of seven events of Operation Nougat.

NAME OF EVENT	Antler	Feather	Pampas	Danny Boy	Platte	Eel	Des Moines
Date of Event	9-15-61	12-22-61	3-1-62	3-5-62	4-14-62	5-19-62	6-13-62
Time of H hour	1000 PDT	0830 PST	1110 PST	1015 PST	1000 PST	0800 PDT	1400 PDT
AERIAL MONITORING:							
Aircraft type	L-20	U3-A	L-20	U3-A	U3-A	U3-A	U3-A
Mission duration	3-h 15-m	3-h 35-m	2-h 40-m	2-h 51-m	4-h 30-m	2-h 50-m	3-h 2-m
End of Mission	H + 4:15	H + 3:55	H +2:40	H + 3:17	H + 4:30	H + 2:50	H + 3:02
GROUND MONITORING:							
Number of teams	5	5	13	18	10	9	12
Mission duration	5-h 40-m	7-h 35-m	8-h 5-m	10-h 25-m	9-h 25-m	12-h 45-m	8-h 30-m
End of Mission	H + 6:40	H +9:05	H + 8:15	H +11:45*	H + 9:30*	H + 13:50*	H + 8:10*
Highest Reading:							
Dose Rate (mr/hr)	12.5	0.08	0.22	0.47	7.0	10	160
Time (clock)	1317	1611	1544	1325	1314	0941	1527
Location	Twin Spgs. Ranch	Death Valley Jct.	Gunderson's Ranch	Warm Spgs.	Diablo***	Queen City Summit**	Queen City Summit
Dose Rate Recorders	3	4	2	7	5	2	7
AIR SAMPLING:							
Number of Samplers	13	20	24	24	26	26	26
Number with Cartridges	10	9	4	6	5	7	6
High filter activity pc/M^3 at:	28 CP	440 MP	1700 MP	1000 MP	34,000 MP	3400 MP	15,000 CP
Location of high filter	Diablo	Bettle's Farm	Gunderson's Ranch	Warm Spgs.	Queen City Summit**	Currant	Queen City Summit**

* Remonitoring of some areas carried out on the following day.

** Queen City Summit is a point of high elevation on Highway 25. The net dose rate of 10 mr/hr was measured on Hwy. 25 5.9 miles northwest of the Summit. High filter activity at residential locations was 10,000 pc/M^3 at Diablo and Lund after PLATTE, and 5,900 pc/M^3 at Diablo after DES MOINES.

*** See page 94.

MP Mid point of collection period.

CP Time of peak activity during cloud passage over the sampler.

Table 5.2.2 Off-site locations instrumented during seven events of Operation Nougat

LOCATION	Antler	Feather	Pampas	Danny Boy	Platte	Eel	Des Moines
Alamo	FC	F	F	F	F	F	F
Ash Meadows		FC					
Beatty	FC	FC	F	F	F	F	F
Bettle's Ranch		FC					
Caliente	F	F	F	F	F	F	F
Carver's Rest.				FCR			
Currant			F	F	F	FCR	FR
Death Valley Jct.		FCR	F	F	F	F	F
Diablo	FCR	F	FCR	FR	FCR	FC	FCR
Ely			F	F	F	FC	F
Enterprise, Utah			F	F	F	F	F
Eureka							FC
Furnace Creek		FCR	F	F	F	F	F
Goldfield	FC	F	F	F	F	F	F
Gunderson's R.	FCR	FC	FCR	FCR	FCR	FCR	FCR
Hiko	FC	F	F	F	F	F	F
Indian Springs		F	F		F	F	F
Las Vegas		F	F	F	F	F	F
Lathrop Wells	FC	FCR	F	F	F	F	F
Lockes							R
Lund			F	F	F	FC	FC
Mesquite			F		F	F	F
Pahrump			F	F	F	F	F
Pioche			F	F	F	F	F
St. George, Utah	F	F	F	F	F	F	F
Scotty's Jct.			F	FCR	F	F	F
Shoshone		FC					
Stovepipe Wells		FCR					
Tempiute						FC	
Tonopah	FC	F	F	FCR	F	F	F
Twin Springs R.						FC	F
Warm Springs	FC	F	FC	FCR	FCR	F	FCR
Warm Springs R.	F	F	F	F	F	F	F
Bald Mountain	FC						
Queen City Summit					FCR		FC
Reed	R			FCR	FCR		R
Currant Mnt. Sta.							R

F - air sampler with filter; C - air sampler with filter and charcoal cartridge; R - dose rate recorder.

are located on the map figures included in the description of each event given in Section 5.3, and the concentrations of radioactive materials in air in samples associated with each event are given in the detailed tables of Appendix C.

In general, the activity levels found in off-site locations were quite low compared to those measured during previous weapons tests at the Nevada Test Site [14, 15, 16]. Also, the radioactivity released during Nougat was usually associated with gaseous material vented from the underground detonations, rather than with particulate fallout seen to result from the atmospheric tests of past operations.

5.2.1 External Radiation Dose Rates

The highest external gamma dose rates measured by ground monitoring teams occurred after the Des Moines event on June 13, 1962. Maximum readings were 100 mr/hr on Highway 6, thirteen miles southwest of Currant, and 160 mr/hr at Queen City Summit, a point of high elevation on Highway 25, north of the test site. The 100 mr/hr peak on Highway 6 lasted for four minutes and had dropped to 30 mr/hr within eleven minutes. The peak reading at Queen City Summit was also of short duration, remaining between 80 and 160 mr/hr for twenty minutes, and then dropping rapidly to less than 10 mr/hr. The residential location having the highest gamma dose rate observed during Operation Nougat was Nyala, where a reading of 100 mr/hr was taken two hours and fifty minutes after the Des Moines detonation. Again, this peak dose rate was not maintained for long, having dropped to 8 mr/hr within the following hour. All ground monitoring data taken off site during the seven Nougat events which released activity to the off-site area are tabulated in Appendix A.

5.2.2 Film Badge Exposures

Film badge dosimetry showed that of the 240 off-site residents badged, only twenty percent received exposures above the 30 mr detection limit. The maximum exposure read from a single badge was received by an individual living at Hiko. This badge indicated a dose of 285 mr received over the 14-day period between June 18, and July 1, 1962. The film badge station at Reed, an unpopulated location just outside the test site boundary, showed the maximum exposure for Operation Nougat with a reading of 1080 mr from exposure received between April 25 and June 29, 1962. Badges from the reference stations at Blue Eagle Ranch showed exposures of 90 and 125 mr between June 11 and 19. Badges worn by residents of the ranch during that exposure period indicated from 50 to 100 mr.

Gamma exposure read from film badges worn by off-site residents, at reference stations, and at regular film badge stations in the off-site area are presented in the tables of Appendix B. The locations of these badges are shown in the figures of this appendix together with graphs showing exposures to film badge stations received throughout Operation Nougat.

5.2.3 Airborne Radioactivity

The highest concentrations of radioactivity in air were seen in samples taken after both the Platte and Des Moines events. On a single air filter the maximum concentration of gross beta activity was 34,000 pc/M^3 corrected for decay to the mid-point of the sampling period. This sample was associated with the Platte event, and was taken from Queen City Summit on Highway 25. At residential locations, the highest concentration of gross beta activity in air was 10,000 pc/M^3 found in samples collected at Diablo and at Lund, also during surveillance for the Platte event.

The highest concentrations of iodine isotopes in air, as measured by gamma pulse height analysis of charcoal cartridges, were also associated with the Platte and Des Moines events. The cartridge from the sampler at Queen City Summit during Platte, collecting 84.2 cubic meters of air between 1250 and 1540 hours on April 14 (approximately H + 3 to H + 5) contained the highest concentrations of iodine isotopes seen throughout Operation Nougat. As corrected for radioactive decay to the mid-point or end of the sampling period, but not corrected for ingrowth from decay of precursors, this cartridge contained I^{131}, Te^{132}, I^{133}, and I^{135} in concentrations of 267 pc, 170 pc, 5,550 pc, and 17,800 pc per cubic meter respectively. The highest concentrations of the same isotopes detected by a cartridge sampling at a residential location were 55.3, trace, 762, and 2,800 pc/M^3 at Diablo again after the Platte event.

These data are shown in more detail in the tables of Appendix C. From these tables it will be seen that of the air sampled in association with specific events, twenty-six samples contained gross beta activity in concentrations greater than 100 pc/M^3. These twenty-six samples were collected from eleven different locations, nine of which were residential. The data reported in Appendix C pertain to shot-related samples, and therefore often represent sampling periods of less than 24 hours duration. Also, locations such as Gunderson's Ranch, Reed, and Queen City Summit were not routine air sampling locations, but were instrumented only for specific events.

If the average activity for each day is considered for the routinely sampled residential locations, gross beta concentrations greater than 100 pc/M^3 were seen to occur in only nine instances at six different locations. When gross beta activity at each routinely sampled location was averaged over the number of full days the station operated, no station showed an average as high as 100 pc/M^3. Only ten of the twenty-six stations so averaged showed concentrations greater than 10 pc/M^3. Nine of these ten stations were in operation for more than 100 days during the period of Operation Nougat.

Figure 5.2.1 shows the average concentration of gross beta activity in air at the twenty-six routinely sampled locations with respect to the number of days the air was sampled. Most filters from which these data were obtained were counted five and seven days after collection to allow for decay of natural radioactivity. A $T^{-1.2}$ extrapolation was made to normalize activity to end of collection period for each filter. Only those filters collected for a specific event were counted as soon

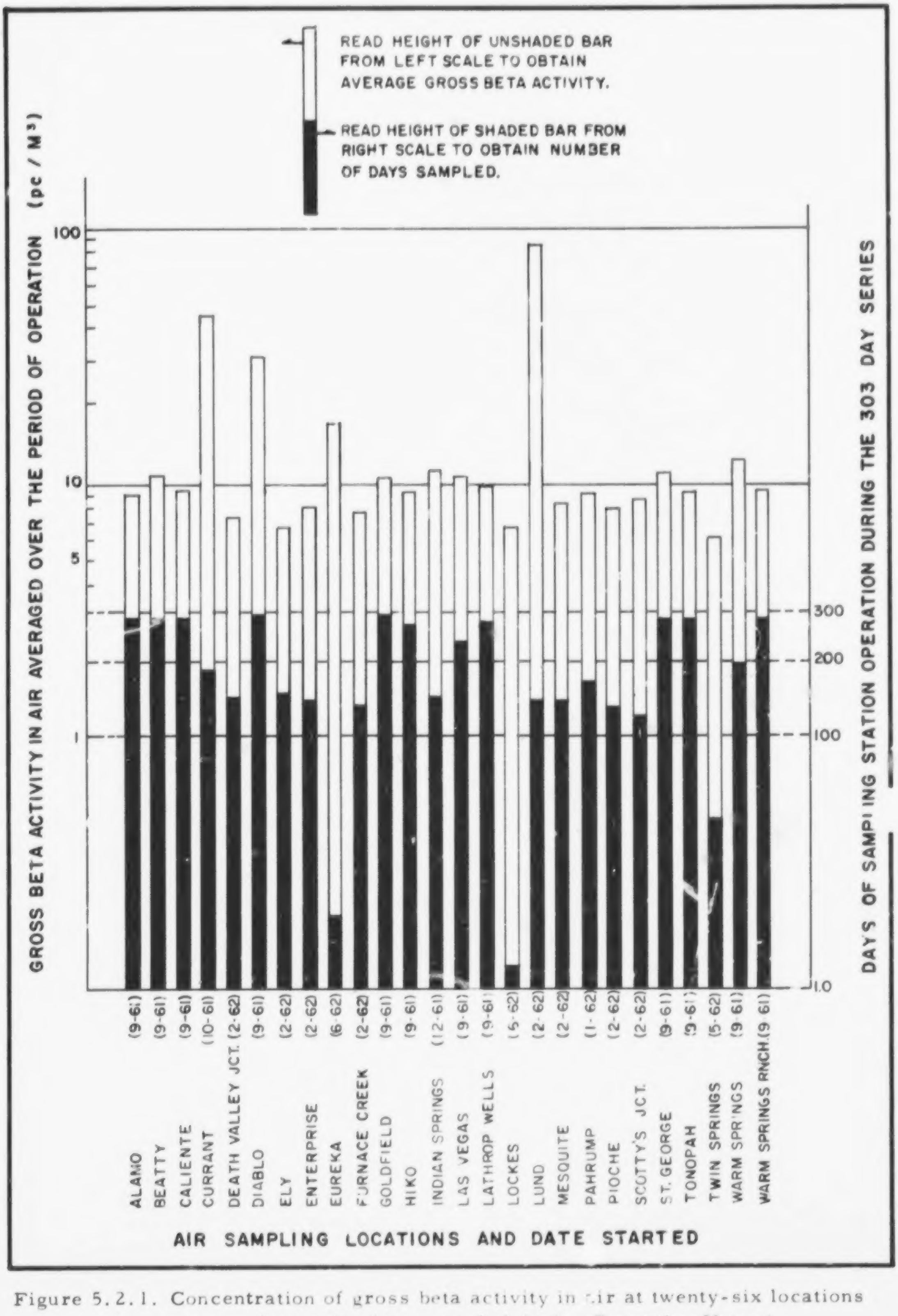


Figure 5.2.1. Concentration of gross beta activity in air at twenty-six locations averaged over the days sampled during Operation Nougat.

as possible after collection, and they were normalized by extrapolating along a decay curve derived empirically for each filter. Discrepancies resulting from the two computation methods are insignificant in the final average obtained.

Most filters were not examined for gamma activity, and charcoal cartridges were not routinely used at most sampling stations. However, the results of gamma pulse height analyses of filters having unusually high beta activity and of cartridges used in surveillance of specific shots can be summed to give a reasonable estimate of the total isotope concentration at most sampling locations. The ratio of the total activity of each iodine isotope detected to the maximum permissible concentration for the general population (one-tenth the value listed in NBS Handbook 69) was calculated for each location by combining all activity detected during the series at that location. Ratios greater than 0.001 occurred at only two locations. These were Currant and Diablo, Nevada. At Currant the ratio of total I^{131} activity to the $(MPC)_a$ for I^{131} was 0.007. At Diablo the ratios of I^{131} and of I^{133} to their respective $(MPC)_a$ values were 0.003 for I^{131} and 0.009 for I^{133}.

5.2.4 Radioactive Contamination of Water and Milk

No significant radioactive contamination of water supplies resulted from the Nougat series. The maximum concentration of gross beta activity found in well water was 54 picocuries per liter in a sample from Tonopah, Nevada, collected on May 16, 1962. The highest activity in a sample of non-potable water was found in the March 30 sample from Hot Creek Pond which contained 273 picocuries of gross beta activity per liter. Results of water sample analyses are tabulated in Appendix D.

The highest concentration of a fresh fission product in milk was 720 picocuries of I^{131} per liter in a sample from Hiko, Nevada, on November 2, 1961. Samples from Hiko taken on December 13, 1961, and on May 17, 1962, contained less than 10 picocuries of I^{131} per liter. Data from analysis of milk samples will also be found in Appendix D, except for milk collected as part of the St. George, Utah ecology study. These data have been tabulated in Chapter 3.

5.3 SUMMARIES OF INDIVIDUAL EVENTS

Discussed below are the off-site surveillance activities performed for each of the seven events of Operation Nougat in which detectable radioactivity was released to the off-site area. The events are treated in chronological order. A figure showing the location of sampling points and areas monitored is included with each summary. Detailed tables of monitoring and of sampling data are arranged in the same chronological order in Appendices A and C respectively.

5.3.1 Antler

The Antler event was the first of the Nougat series. It was a tunnel shot in Area 12 detonated at 1000 hours PDT on September 15, 1961, by the Lawrence Radiation Laboratory. A gaseous cloud of radioactive material was released from the tunnel and moved north from Ground Zero at about 11 miles per hour, entering the off-site area near Reed.

Five mobile ground monitoring teams and one aerial cloud tracking team in a U. S. Air Force L-20 aircraft tracked the cloud and measured its radioactivity. Thirteen air samplers, ten of which held charcoal cartridges in addition to glass fiber filters were in operation at off-site locations. Three dose rate recorders were also in use.

Aerial cloud tracking. The aerial team tracked the cloud from 1100 until 1415 hours, when the mission was terminated due to low readings. It first detected the cloud in the off-site area at 1148 hours over Reed, where readings were in excess of 5 mr/hr and the cloud width was estimated at 5.5 miles. The reading over Twin Springs Ranch at 1204 hours was background. Between 1238 and 1327 hours the aircraft was refueling at Tonopah. After refueling, no readings above background were detected from Tonopah to Warm Springs between 1327 and 1342 hours. The cloud was detected three miles east of Warm Springs at 1346 with a reading of 0.15 mr/hr at 9000 feet mean sea level (MSL). The reading two miles west of Twin Springs at 1347 hours was 0.3 mr/hr, and two miles east of the ranch it was 0.25 mr/hr at 1350 hours. Over Diablo at 1410, the reading was background, while over Reed at 9500 feet MSL a reading of 0.15 mr/hr was observed at 1415 hours. At this time the aerial surveillance mission was terminated.

Ground monitoring. Gamma dose rates above background were detected by ground monitoring teams along the roads shown on the map in Figure 5.3.1. Three populated locations fell within this area. At Diablo the net dose rate was 0.10 mr/hr at 1243 and 1440 hours.

although it had dropped to 0.02 mr/hr at 1319 hours. At Twin Springs Ranch the first reading taken showed a net dose rate of 12.5 mr/hr at 1317 hours. In about an hour it had dropped by a factor of ten, and by 1620 hours was down to 0.04 mr/hr. At Warm Springs the net dose rate of 0.28 mr/hr at 1342 hours had dropped to 0.17 mr/hr at 1500 hours, and reached background level approximately one hour after that.

Dose rate recorders. The dose rate recorder at Gunderson's Ranch detected background dose rates indicating the cloud did not reach this location. The recorder at Diablo showed that the cloud arrived at 1231 hours. Gross gamma dose rate rose to a peak of 0.15 mr/hr within the following three minutes, then dropped to a low of 0.03 mr/hr (essentially background) by 1415 hours. It began rising again to a rate in excess of 0.2 mr/hr where it remained between 1415 and 1430 hours. From 1430 to 1650 hours, the record showed a decrease in dose rate to 0.04 mr/hr and a further decrease to background by 1900 hours.

The record from the recorder at Reed showed cloud arrival at 1117 hours with the peak above 0.2 mr/hr. At 1145 hours, the reading was 0.12 mr/hr. Dose rate then rose again to greater than 0.2 mr/hr and remained at this level until 1240 hours.

Sampling. The only glass fiber filter which collected air having gross beta activity in a concentration greater than background came from the sampler at Diablo. Fresh fission products were present in the cartridges sampling at Diablo and Warm Springs. Data from analses of air samples collected during surveillance for Antler are in Table 1 of Appendix C.

Samples of desert vegetation were taken at Diablo and at Twin Springs Ranch. No fresh fission products were found on the sample from Diablo, although small, but detectable amounts of I^{131} and I^{133} were identified in the one from Twin Springs Ranch.

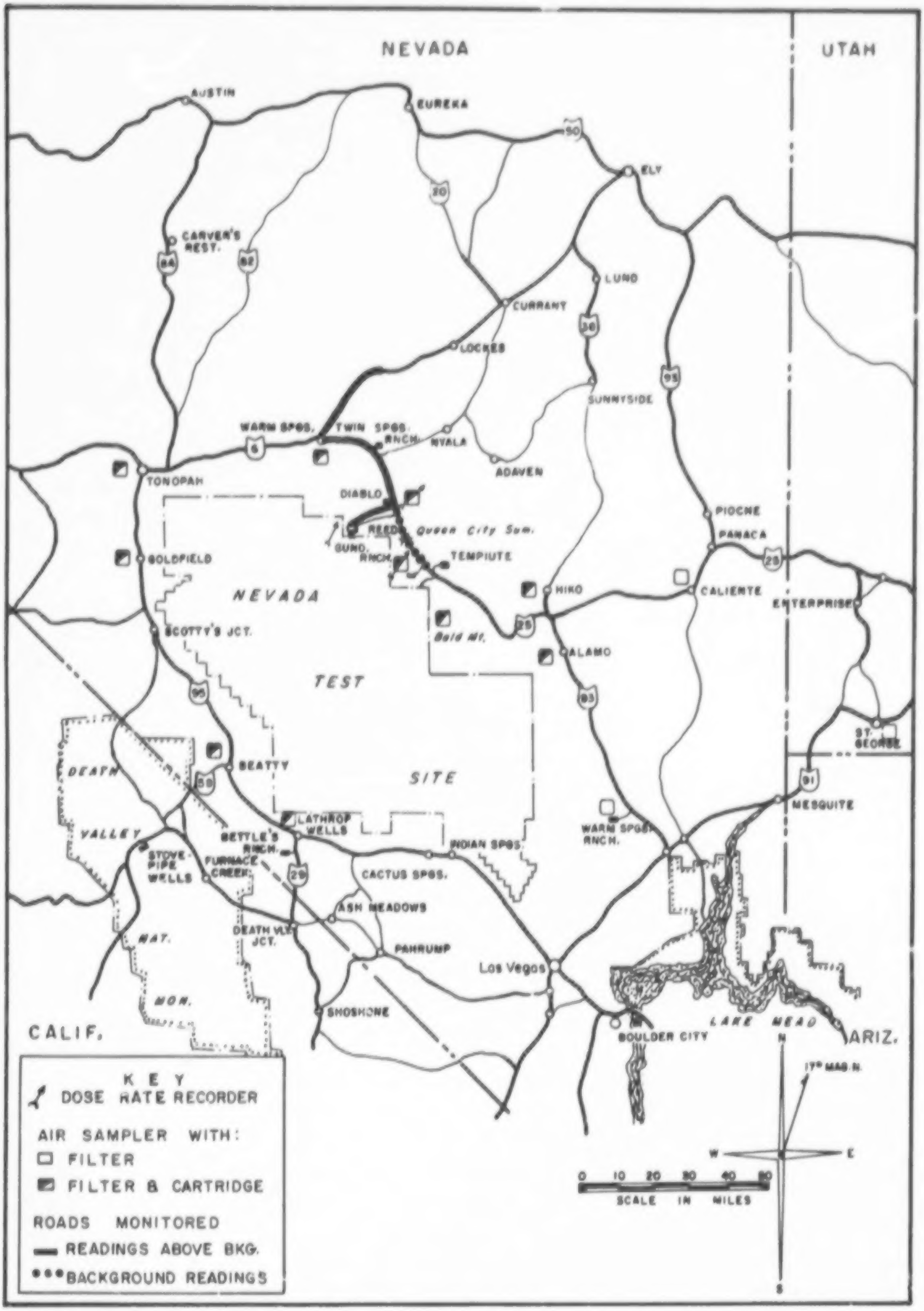

NEVADA
UTAH
AUSTIN
EUREKA
50
ELY
20
CARVER'S REST.
84
82
LUND
CURRANT
38
LOCKES
SUNNYSIDE
93
WARM SPGS.
TWIN SPGS. RNCH.
NYALA
6
ADAVEN
TONOPAH
DIABLO
REED
Queen City Sum.
GUND. RNCH.
TEMPIUTE
PIOCHE
PANACA
GOLDFIELD
25
HIKO
CALIENTE
ENTERPRISE
NEVADA
SCOTTY'S JCT.
Bald Mt.
ALAMO
TEST
95
ST. GEORGE
DEATH
BEATTY
SITE
91
MESQUITE
58
LATHROP WELLS
VALLEY
BETTLE'S RNCH.
INDIAN SPGS.
WARM SPGS. RNCH.
STOVE-PIPE WELLS
FURNACE CREEK
29
CACTUS SPGS.
ASH MEADOWS
NAT.
DEATH VLY. JCT.
PAHRUMP
Las Vegas
MON.
SHOSHONE
CALIF.
BOULDER CITY
LAKE MEAD
ARIZ.
N
17° MAG. N.
W
E
S
0 10 20 30 40 50
SCALE IN MILES
KEY
DOSE RATE RECORDER
AIR SAMPLER WITH:
☐ FILTER
▨ FILTER & CARTRIDGE
ROADS MONITORED
— READINGS ABOVE BKG.
••• BACKGROUND READINGS

Figure 5.3.1. Off-site surveillance locations for the Antler event on September 15, 1961.

5.3.2 Feather

Feather was the eighth announced event of the Nougat series. It was a tunnel shot in Area 12, detonated by the Lawrence Radiation Laboratory on December 22, 1961 at 0830 hours PST. The test released gaseous radioactive material which moved on a bearing of 210-220 degrees from Ground Zero and crossed Highway 95 approximately seventeen miles northwest of Lathrop Wells.

One aerial cloud tracking team in a U. S. Air Force U3-A aircraft, five mobile ground monitoring teams, and four dose rate recorders tracked and monitored the radioactivity released to the off-site area. Twenty air samplers, nine of which contained charcoal cartridges as back-up filters, were operated at off-site locations.

Aerial cloud tracking. Aerial tracking showed the cloud entered the off-site area east of Beatty. At 1117 hours, approximately 10 miles east of Beatty, a reading of 0.3 mr/hr was obtained. The leading edge of the cloud was estimated to be about five miles north of Highway 95 at this time and the maximum reading in this area (taken at 7,000 feet MSL) was 5 mr/hr. At 1147 hours, the cloud was detected crossing Highway 95 about seventeen miles northwest of Lathrop Wells, with a reading of 0.14 mr/hr at 7,500 feet MSL. At 1206 hours, 1.0 mr/hr was the dose rate at 6,000 feet MSL sixteen and one-half miles northwest of Lathrop Wells. The dose rate was twice that value four miles north and three minutes later. This 2.0 mr/hr reading was taken taken at 6,300 feet MSL. The cloud extended from approximately 13.5 to 19.5 miles northwest of Lathrop Wells at 1220 hours. At 1225 hours the aerial surveillance mission was terminated.

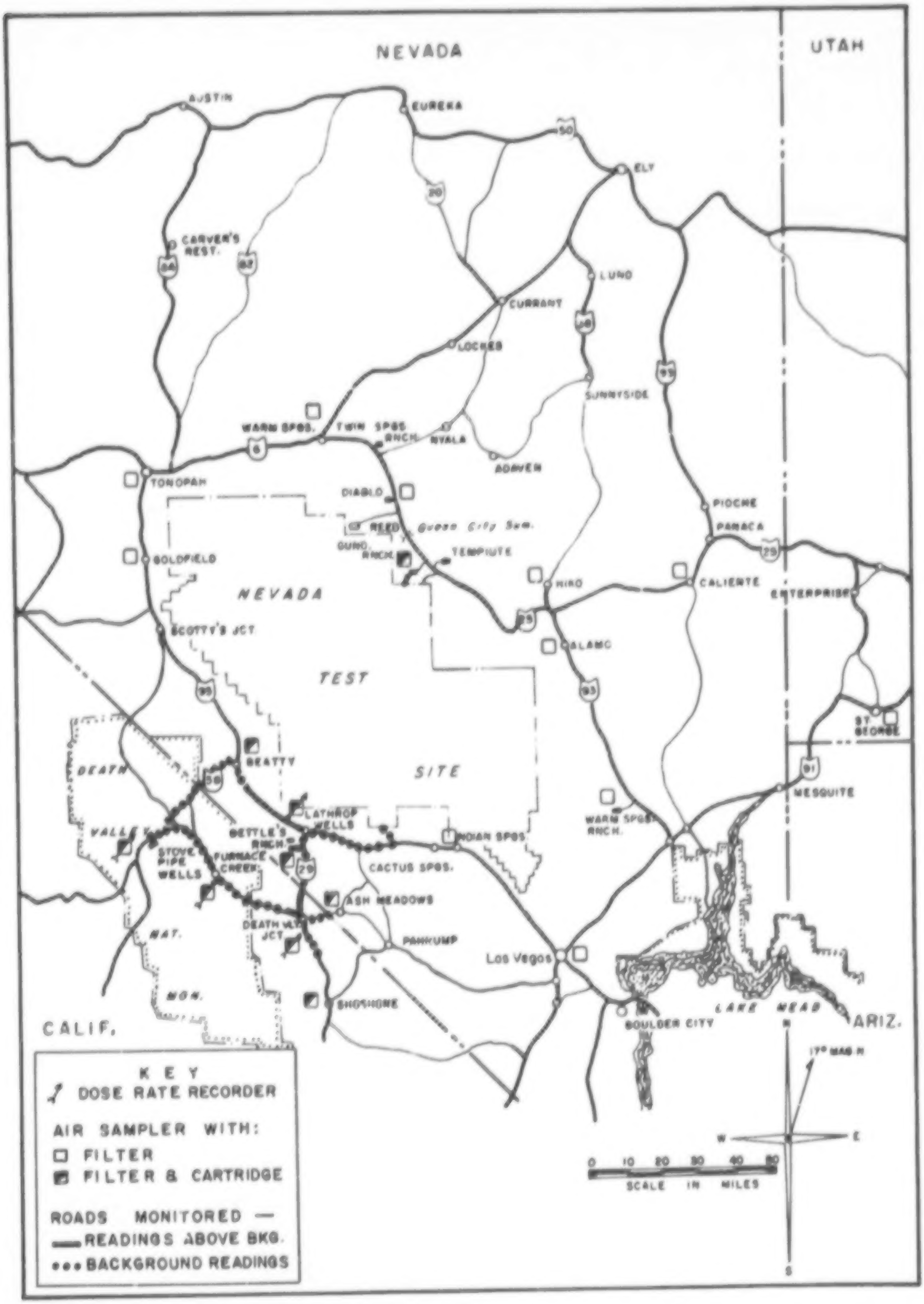
Ground monitoring. Ground monitors detected low net gamma dose rates in the narrow sector shown on the map in Figure 5.3.2. All readings taken at Gunderson's Ranch, Furnace Creek, and Stovepipe Wells were at background. At Lathrop Wells, one reading of 0.02 mr/hr was taken at 1550 hours. At Bettle's Farm, 48 miles from Ground Zero, a maximum net dose rate of 0.06 mr/hr was detected at 1535 hours. By 1700 hours, readings had dropped to 0.01 mr/hr above background. Activity was first detected at Death Valley Junction at 1610 hours, where it rose to a peak of 0.08 mr/hr at 1611 hours, and dropped to 0.02 mr/hr twenty-four minutes later.

Dose rate was measured on the following day at Beatty and at Stovepipe Wells. Readings were background. Ground monitoring data for the Feather event are tabulated in Appendix A, Table 2.

Dose rate recorders. Of the four recorders operating at the locations shown in Figure 5.3.2, the one at Death Valley Junction, 60 miles and 190 degrees from Ground Zero, gave the only record showing presence of the Feather cloud. At 1825 hours on December 22, when the record was started, net gamma dose rate was 0.01 mr/hr. This had dropped to background by 1910 hours, and no change in dose rate had occurred when the record was stopped at 0815 hours the next morning.

Sampling. Of the twenty locations instrumented with air samplers, only five yielded filters showing gross beta activity above background concentrations. The highest concentration was sampled at Bettle's Farm, where the filter collecting from 1530 to 1705 hours on December 22 showed 440 pc/M^3, as corrected for decay to mid-point of collection. Fresh fission products were detected on filters from Lathrop Wells, Bettle's Farm, and Death Valley Junction, and on charcoal cartridges from these three locations as well as from Ash Meadows and Shoshone. The air sampling data are listed in Table 2 of Appendix C.

No other environmental samples were collected specifically for surveillance of Feather.


NEVADA
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CARVER'S REST.
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LUND
CURRANT
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LOCKES
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SUNNYSIDE
WARM SPGS.
TWIN SPGS RNCH.
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Queen City Sum.
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BETTLE'S RNCH.
INDIAN SPGS.
WARM SPGS. RNCH.
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Los Vegas
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SHOSHONE
LAKE MEAD
BOULDER CITY
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40
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SCALE IN MILES
KEY
DOSE RATE RECORDER
AIR SAMPLER WITH:
□ FILTER
▨ FILTER & CARTRIDGE
ROADS MONITORED —
READINGS ABOVE BKG.
••• BACKGROUND READINGS

Figure 5.3.2. Off-site surveillance locations for the Feather event on December 22, 1961.

5.3.3 Pampas

After Feather, weapons tests released no detectable radioactivity to the off-site area until March 1, when the Los Alamos Scientific Laboratory conducted Pampas, the nineteenth event of the Operation, in Area 3. This well shot, detonated at 1110 hours PST, released gaseous radioactive material which moved on about a ten degree trajectory to enter the off-site area over Gunderson's Ranch in Penoyer Valley.

One aerial and thirteen ground monitoring teams, two dose rate recorders, and twenty-four air samplers, four of them with charcoal cartridges, gathered surveillance information for Pampas. External gamma exposure off-site was very low, the highest net dose rate three feet above ground being 0.22 mr/hr. The highest concentration of gross beta activity in air, as sampled by a single filter, was 1700 pc/M^3 at Gunderson's Ranch.

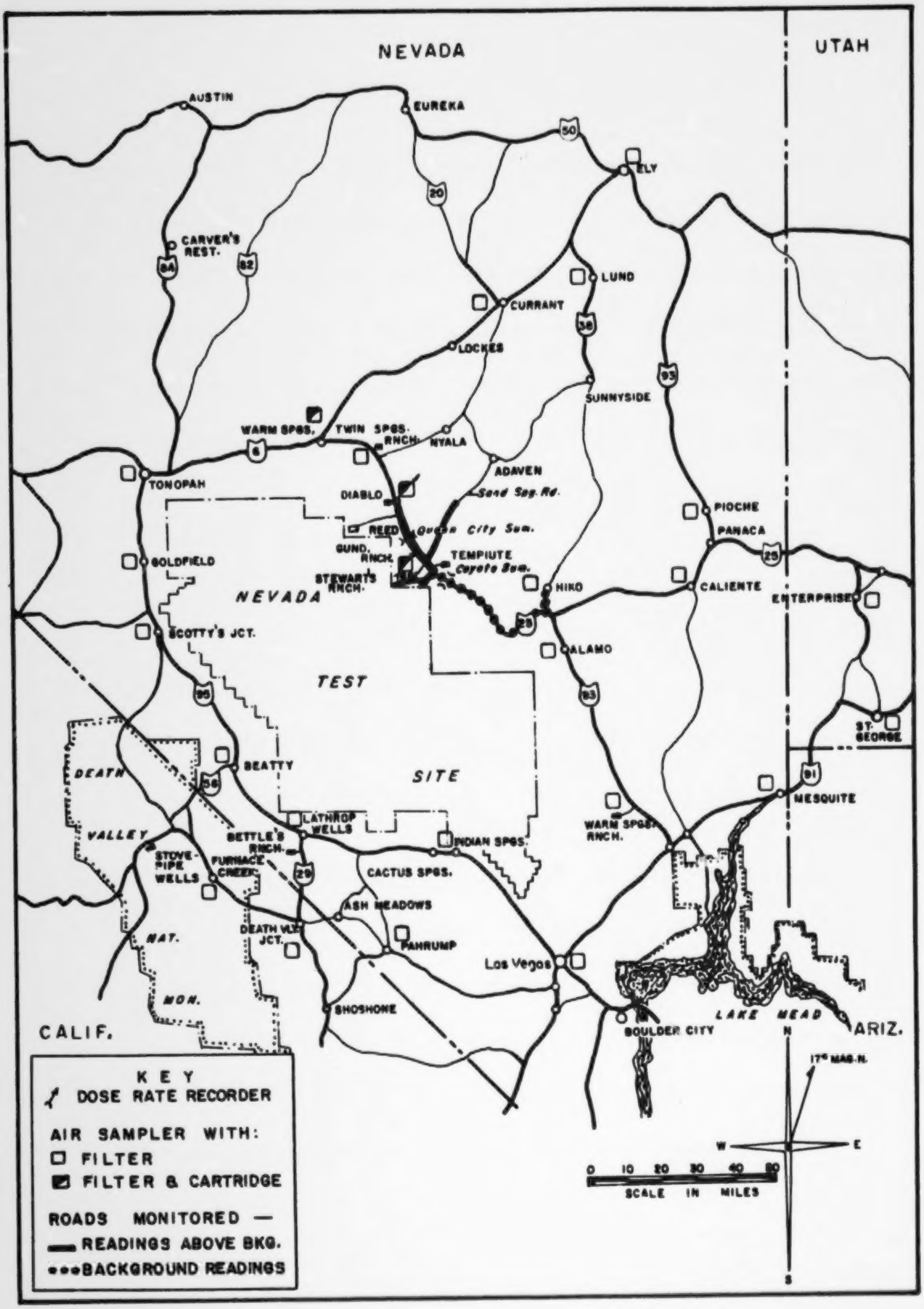
Aerial cloud tracking. A U. S. Air Force L-20 aircraft and crew were supplied to the PHS cloud tracking team, which monitored Pampas from 1110 until 1350 hours. Although at this time the body of the cloud had not entered the off-site area, the aircraft's fuel was low and the mission was terminated.

Ground monitoring. A dose rate above background was first detected at 1330 hours. This was at Gunderson's Ranch, where net gamma dose rate rose very slowly from an initial value of 0.01 mr/hr to a maximum of 0.22 mr/hr at 1544 hours. By 1745 hours, it had dropped to 0.01 mr/hr. The first indication of cloud arrival at Diablo was a net gamma dose rate reading of 0.01 mr/hr taken at 1652 hours. Dose rate there reached a peak of 0.08 mr/hr at 1708 hours. Thirty-two minutes later it had dropped to background level. The Pampas cloud crossed Highway 25 between the Valley Road turn-off and Diablo, as shown on the map in Figure 5.3.3. Dose rate readings taken off site during Pampas are tabulated in Table 3 of Appendix A.

Dose rate recorders. Records from dose rate recorders at Diablo and at Gunderson's Ranch substantiated cloud passage information taken by monitoring teams. The record from Gunderson's ran from 1400 to 1730 hours. Low dose rates fluctuated between 0.03 and 0.10 mr/hr (gross gamma) until they rose above 0.15 mr/hr between 1530 and 1550. By 1600, the tracing showed dose rates below 0.05 mr/hr.

The record from Diablo showed the increase in dose rate to be a smooth, sharp rise at about 1645 to a peak level slightly above 0.08 mr/hr just after 1700 hours. Dose rate dropped rapidly to 0.04 mr/hr at 1730, and then very slowly until 1930 hours when the record stopped.

Sampling. Air samplers at Gunderson's Ranch, Diablo, and Hiko collected fresh fission products. The filter from Gunderson's, which showed a gross beta activity concentration of 1700 pc/M^3 between 1245 and 1750 hours on March 1, contained 8.6, 180 and 240 pc/M^3 of iodines 131, 132, and 133, as corrected for decay to the mid-point of the sampling period. Iodine-133 and iodine-135 were seen on the cartridge which sampled concurrently. Although air sampled by the filter at Diablo between 1330 and 1730 hours contained gross beta activity at only 830 pc/M^3, it contained about the same concentrations of iodine isotopes as did the air sampled at Gunderson's Ranch. The cartridge at Diablo also contained Iodine-133 and -135. The cartridge from Hiko indicated that a low concentration of iodine-133 had been present between 1625 hours on March 1, and 0900 hours the following day. These data are presented in Appendix C, Table 3.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CARVER'S REST.
84
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LUND
CURRANT
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LOCKES
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TWIN SPGS. RNCH.
NYALA
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ADAVEN
TONOPAH
DIABLO
Sand Spg. Rd.
PIOCHE
REED
Queen City Sum.
PANACA
GUND. RNCH.
TEMPIUTE
Coyote Sum.
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GOLDFIELD
STEWART'S RNCH.
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WARM SPGS. RNCH.
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SCALE IN MILES
KEY
DOSE RATE RECORDER
AIR SAMPLER WITH:
☐ FILTER
▨ FILTER & CARTRIDGE
ROADS MONITORED —
READINGS ABOVE BKG.
BACKGROUND READINGS

Figure 5.3.3. Off-site surveillance locations for the Pampas event on March 1, 1962

5.3.4 Danny Boy

Danny Boy, the next announced event and twentieth of the series, was a cratering experiment conducted by the Department of Defense on March 5, 1962. The Danny Boy device was detonated in a well in Area 18 at 1015 hours PST. The resulting cloud traveled to the north, crossing Highway 6 west of Warm Springs. The highest net gamma dose rate detected off site was 0.47 mr/hr at Warm Springs at approximately H + 3-1/4 hours.

An aerial cloud tracking team, eighteen ground monitoring teams, and seven Eberline RM-5 recorders tracked and monitored radioactivity in the off-site area. Twenty-four air samplers were operated in off-site locations, and six locations were sampled with charcoal cartridges as well as with filters.

Aerial cloud tracking. The aerial team in an Air Force U3-A aircraft first detected the cloud off site to the north of Silver Bow, a deserted ranch on the northern boundary of the test site. A pass to the north from Silver Bow was made at 8,000 feet MSL with the following readings: two miles north at 1028 hours, 12 mr/hr; three miles north at 1229 hours, 20 mr/hr; four miles north one-half minute later, 26 mr/hr. At 1230 hours, over Highway 6 thirteen miles west of Warm Springs, the reading was 60 mr/hr. The cloud was estimated to be seven miles wide at this time.

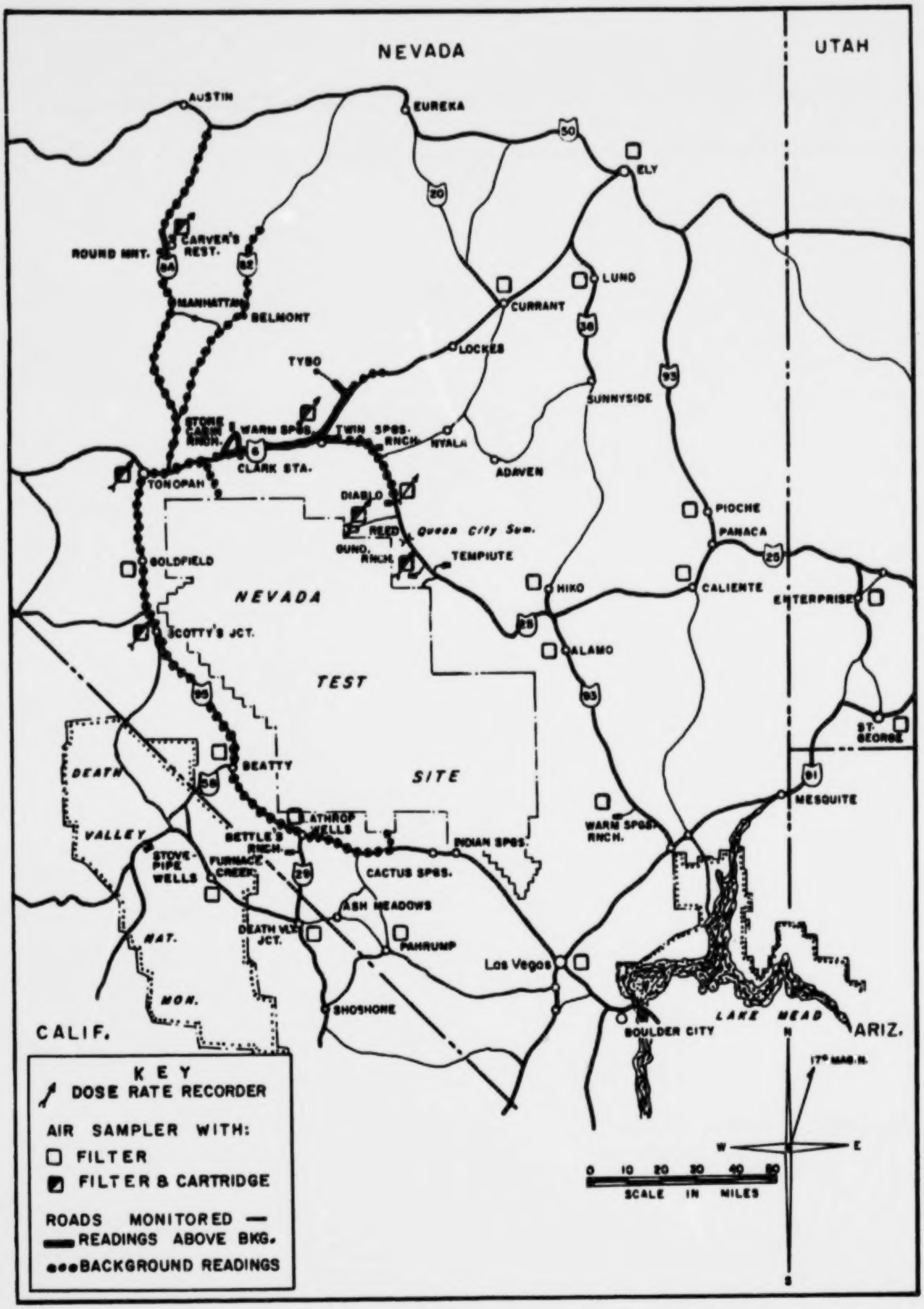
A snowstorm encountered near Highway 6 made further tracking impossible. The aircraft therefore returned to the test site and terminated its mission shortly after 1307 hours.

Ground monitoring. As Figure 5.3.4 shows, monitoring for the Danny Boy event covered an extensive area to the north and east of Ground Zero. Dose rate readings above background were obtained only in the small sector of Highways 6 and 25 from west of Clarks Station to just north of the road to Tybo and just east of Warm Springs. A rise of 0.02 mr/hr above background dose rate was observed at Carver's Restaurant on Route 8A, 121 miles from Ground Zero. This indication of the cloud's presence lasted less than 30 minutes. The highest net gamma dose rate detected was 0.47 mr/hr at Warm Springs immediately after cloud arrival at 1325 hours.

Route 8A from Carver's Restaurant south to the 8A-Highway 6 junction, and Highway 6 from the junction to Clarks Station, were monitored again on the day following Danny Boy. Only a few readings above background were obtained, the highest of which was 0.08 mr/hr at the Stone Cabin Ranch north of Clarks Station. All dose rate readings taken off site during surveillance of Danny Boy are listed in Table 4 of Appendix A.

Dose rate recorders. Only one of the seven dose rate recorders in operation off site showed dose rates above background. This was at Warm Springs where the record showed cloud arrival at approximately 1300 hours, followed by a rise to 0.35 mr/hr by 1330 hours. About 20 minutes later, dose rate increased further to a peak of 0.6 mr/hr just before 1400 hours. This peak dropped rapidly to 0.2 mr/hr at 1420 hours. Only background levels were recorded after 1620 hours.

Sampling. The only glass fiber filter having gross beta activity above background concentration was the one sampling at Warm Springs between 1020 and 1513 hours on March 5. Both this filter and the charcoal cartridge sampling concurrently, contained short-lived iodine isotopes. The cartridge sampling air at Carver's Restaurant between 1715 hours on March 5 and 1530 hours on March 6 contained iodine-131 and -133, although the filter showed only background concentration of gross beta activity. At Warm Springs, 74 miles from Ground Zero, cloud activity was probably predominately in particulate material, but by the time the cloud reached Carver's Restaurant, 121 miles from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CURRANT
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LOCKES
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TYBO
SUNNYSIDE
STONE CABIN RNCH.
WARM SPGS.
TWIN SPGS. RNCH.
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TONOPAH
CLARK STA.
ADAVEN
DIABLO
REED
Queen City Sum.
PIOCHE
PANACA
GUND. RNCH.
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GOLDFIELD
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SCOTTY'S JCT.
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WARM SPGS. RNCH.
BETTLE'S RNCH.
INDIAN SPGS.
STOVE-PIPE WELLS
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DEATH VLY. JCT.
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Las Vegas
SHOSHONE
BOULDER CITY
LAKE MEAD
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SCALE IN MILES
KEY
DOSE RATE RECORDER
AIR SAMPLER WITH:
☐ FILTER
▨ FILTER & CARTRIDGE
ROADS MONITORED —
▬ READINGS ABOVE BKG.
●●● BACKGROUND READINGS

Figure 5.3.4. Off-site surveillance locations for the Danny Boy event on March 5, 1962.

Ground Zero, only gaseous material remained. Data from air samples collected during Danny Boy surveillance are given in Table 4 of Appendix C.

5.3.5 Platte

The next release of radioactive material to the off-site area came over a month later with the Platte event on April 14, 1962. This was a tunnel shot, conducted by the Lawrence Radiation Laboratory in Area 14 at 1000 hours PST. The radioactive cloud, containing both gaseous and particulate material, moved north from Ground Zero at about eighteen miles per hour. It crossed Highway 25 near Queen City Summit, passed between Nyala and Adaven, and crossed Highway 6 north of Currant.

An aerial cloud tracking team followed the cloud's progress for four hours and thirty minutes. Ten ground monitoring teams made dose rate measurements along the cloud path for nine and one-half hours on April 14. They re-monitored several areas on the following day to determine if significant dose rates could be obtained from deposited material. Five dose rate recorders and twenty-six air samplers, five having both filters and cartridges, also documented the effect of the Platte release on the off-site area.

Aerial cloud tracking. At 1221 hours, when the eastern edge of the cloud was found to extend along the Valley Road north of the test site, the tracking aircraft was sent to locate three ranch hands who were reported to be in the path of the approaching cloud. After spotting them and notifying Net Control of their approximate location, the aerial team resumed its cloud tracking mission.

At 1248 hours, the team first detected the cloud in the off-site area with a reading of 20 mr/hr taken at 6000 feet MSL over Gunderson's Ranch in Penoyer Valley. At 1253 hours, a reading of 30 mr/hr was observed at 8000 feet MSL over Queen City Summit. Following Highway 25 north to Diablo, no readings above background were observed there at 1305 hours. One minute later, however, the leading edge of the cloud was detected five miles southeast of Diablo with a reading of 12 mr/hr taken at 7500 feet MSL.

In a pass from twelve miles north of Gunderson's Ranch to fifteen miles north of Queen City Summit at 1314 hours, a reading of 16 mr/hr was obtained at 7500 feet MSL. At 10,000 feet MSL, 20 miles north of Queen City Summit, a reading of 15 mr/hr was obtained at 1347 hours. In a pass from Nyala to Adaven, beginning at 1355 hours, no readings above background were observed.

The mission was terminated at 1430 hours due to low fuel, with no further readings taken over the off-site area.

Ground monitoring. The areas in which dose rate was measured by ground monitoring teams on April 14 are shown on the map in Figure 5.3.5. Cloud activity and velocity measured as the cloud moved out from Ground Zero indicated that dose rates in the off-site area could be expected to be somewhat higher than those previously seen during the Nougat Operation. To insure a minimum exposure to the general population, the portion of Highway 25 within the predicted cloud path was cleared and blocked to traffic until PHS monitors had determined that the cloud had passed without significantly contaminating the highway. Eight vehicles were held at the north roadblock, located at the junction of Highway 25 with the road to Nyala. Two were held at the south road block, established where Valley Road meets Highway 25.

Three ranch hands, who had earlier entered the area covered by the roadblock, were spotted by the aerial cloud tracking team, intercepted by a ground monitor on Sand Springs Road, and were directed to the nearest roadblock where they were surveyed with dose rate meters. Their clothing was found to be only slightly contaminated and no decontamination was necessary. This incident has been described fully in Chapter 2.

The highest dose rate detected off site was 47 mr/hr above background. This was observed at Queen City Summit at 1251 hours, where the cloud was first monitored 34 minutes earlier. Somewhat lower readings were detected along Highway 25 southeast of Queen City Summit. At 1310 hours a net gamma dose rate of 12 mr/hr was detected 4.5 miles southeast of the Summit. These readings are not included with the maxima shown in Table 5.2.1 because they were observed within the area restricted by roadblocks and, therefore, do not apply to the general off-site population.

The highest net gamma dose rate in a populated area was 7.0 mr/hr at Diablo. This measurement was taken at 1314 hours, 43 minutes after cloud arrival. Dose rate decreased steadily from this peak within the next 15 minutes to reach about 1 mr/hr at 1329 hours. The complete sequence of dose rate measurements taken at Diablo will be found in Table 5 of Appendix A.

Maximum gamma dose rate readings taken in other residential locations were the following: Gunderson's Ranch (78°, 22 miles) -1.5 mr/hr at 1221 hours; Adaven (26°, 71 miles) - 1.1 mr/hr at 1705 and 1725 hours; Nyala (17°, 77 miles) - 2.4 mr/hr at 1525 hours; Moon River Ranch (33°, 99 miles) -0.05 mr/hr at 1820 hours;

Currant (19°, 112 miles) -0.2 mr/hr at 1738 hours. The complete tabulation of dose rates measured on April 14 in these and other off-site locations is presented in Appendix A, Table 5.

The measurements of dose rate from deposited material, taken on April 15, are also given in Table 5 of Appendix A. Net gamma dose rate was 0.03 mr/hr both at Gunderson's Ranch at 1212 hours and at Currant at 1245 hours. Readings at Diablo, Warm Springs, and Ely were all background.

Dose rate recorders. The dose rate recorder at Warm Springs showed the Platte cloud did not reach that location. Cloud passage was recorded, however, by those operating at Gunderson's Ranch, Diablo, and Reed. Malfunction of the recorder at Queen City Summit made its record unreadable.

The cloud arrived at Reed shortly after 1200 hours. Gross gamma dose rate reached a peak of 2.0 mr/hr at about 1215 hours, on this record and then fell rapidly to fluctuate between 0.2 and 0.5 mr/hr by 1230 hours. Dose rate remained at 0.2 mr/hr or less after 1320 hours.

At Gunderson's Ranch, maximum gross gamma dose rate indicated by the recorder was 1.4 mr/hr at about 1250 hours. Within the next ten minutes, dose rate dropped below 0.2 mr/hr where it remained for the duration of the record.

The record from Diablo showed cloud arrival to have occurred shortly after 1230 hours. Dose rate rose to a peak of 7 mr/hr at about 1315 hours, then dropped rapidly to about 1 mr/hr. Between 1400 and 2100 hours, when the record ended, dose rate fell slowly from 1 mr/hr to less than 0.5 mr/hr.

Sampling. Of the 26 locations where air was sampled, the highest concentration of gross beta activity occurred at Queen City Summit. The filter which sampled between 1250 and 1540 hours on April 14 showed a concentration of 34,000 pc/M^3 as corrected for decay to the mid-point of that sampling period. Gamma pulse height analysis of this filter showed 3220 pc of I^{131} per cubic meter and from three to six times that concentration of I^{133} and I^{135}. Tellurium-132 was also present on the filter.

The air sampled at Diablo between 1000 and 1605 hours also contained a high concentration of gross beta activity. When activity on the filter was corrected for decay to mid-point of the sampling period and averaged over that entire period, concentration was found to have been 10,000 pc/M^3. Concentration of gross beta activity at Lund averaged over a 25-hour sampling period was also 10,000 pc/M^3, as indicated by the filter inserted at 1745 hours on April 14.

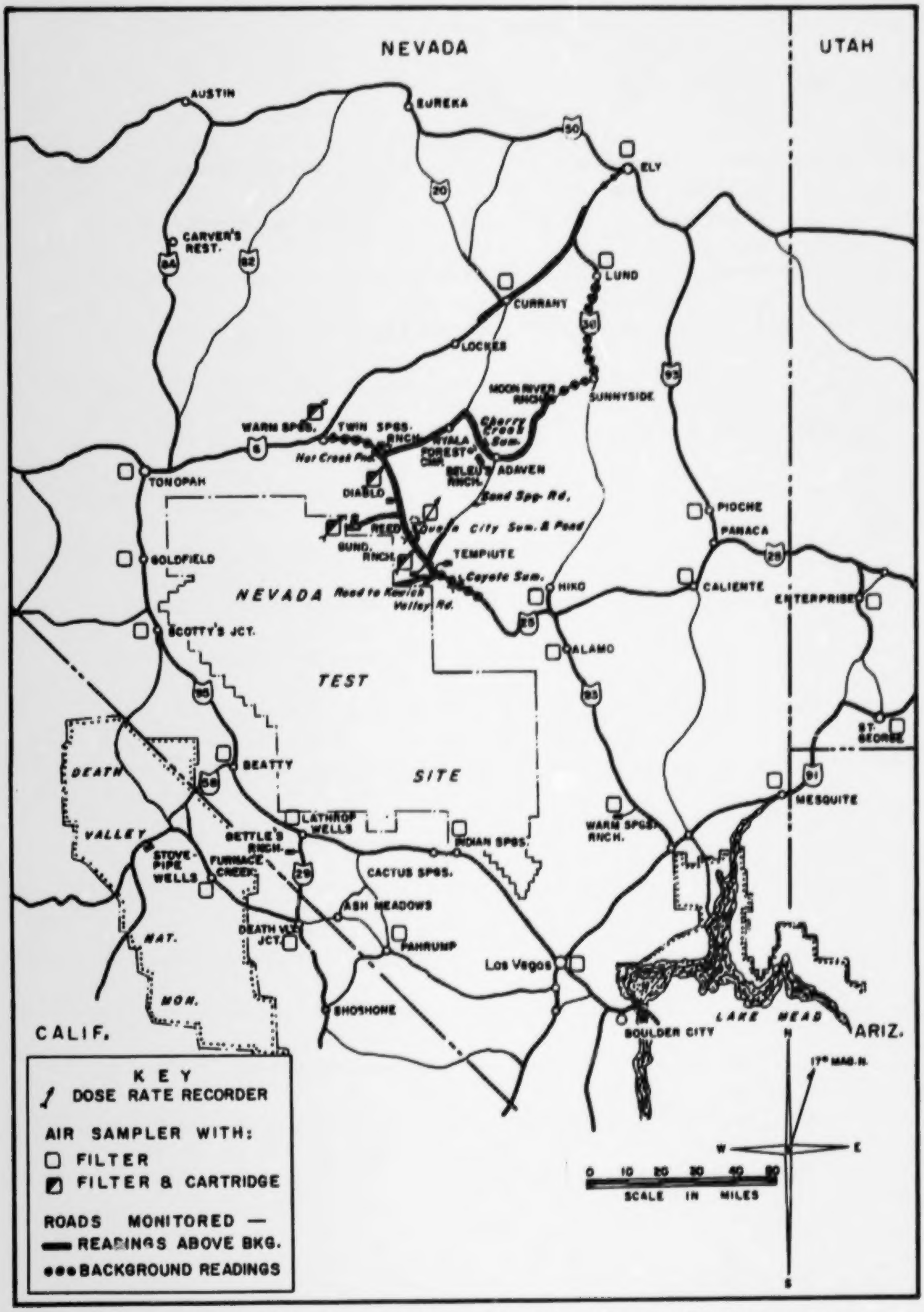
The location farthest from Ground Zero where gross beta activity in air was found to be above background concentration was Ely. Analysis of the filter collecting between 1100 hours on April 14 and 0830 hours on the next day showed average concentration for that period to have been 250 pc/M^3 .

Charcoal cartridges at Queen City Summit, Reed, Diablo, and Gunderson's Ranch contained short-lived iodine isotopes. Of these, I^{135} was seen to be the most highly concentrated when activity at time of analysis was corrected for decay to mid-point of collection. The maximum concentration of I^{135} calculated was 17,800 pc/M^3 at Queen City Summit.

Data from analysis of all filters and cartridges which contained activity above background concentrations are shown in Table 5 of Appendix C.

Water samples collected from Reed at 1330 hours, and from Twin Springs Pond at 1500 hours on April 14 contained no detectable fresh fission products. Water taken from Queen City Pond at 1415 hours on the next day contained 4400 pc I^{133} and 3200 pc Te^{132} per liter. A sample of snow taken near Adaven late in the afternoon of the fourteenth contained measurable amounts of these two isotopes and traces of Ru^{103}- Ru^{105} and Zr^{95}- Nb^{95}.

Only trace amounts of fresh fission products were detected in samples of soil taken from Queen City Summit at 1530 and 1600 hours on April 14. A grab sample of desert vegetation taken there at 1530 hours contained approximately 13 pc of I^{133}, 6 pc of I^{131}, and 4 pc of Te^{132} per kilogram. The same isotopes were present at lower concentrations in two vegetation samples taken near Reed on the next day. These data are not tabulated in the appendices, since the values for concentration of isotopes in grab samples of soil and vegetation are not quantitative for the reasons given in Chapter 4, section 4.7.4.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SUNNYSIDE
WARM SPGS.
TWIN SPGS. RNCH.
NYALA
Cherry Creek Sum.
6
Hot Creek Fnd.
FOREST CMP.
BELEU'S RNCH.
ADAVEN
TONOPAH
DIABLO
Sand Spg. Rd.
PIOCHE
REED
Queen City Sum. & Pond
PANACA
SUND. RNCH.
TEMPIUTE
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GOLDFIELD
Coyote Sum.
NEVADA
Road to Rawich Valley Rd.
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CALIENTE
ENTERPRISE
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ALAMO
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MESQUITE
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LATHROP WELLS
BETTLE'S RNCH.
INDIAN SPGS.
WARM SPGS. RNCH.
STOVE-PIPE WELLS
FURNACE CREEK
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CACTUS SPGS.
ASH MEADOWS
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DEATH VLY. JCT.
PAHRUMP
Los Vegas
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SCALE IN MILES
KEY
DOSE RATE RECORDER
AIR SAMPLER WITH:
☐ FILTER
▨ FILTER & CARTRIDGE
ROADS MONITORED —
READINGS ABOVE BKG.
●●● BACKGROUND READINGS

Figure 5.3.5. Off-site surveillance locations for the Platte event on April 14, 1962.

5.3.6 Eel

The thirty-fourth announced event of the Nougat series released a cloud of radioactive material to the off-site area. This was the Eel event, a well shot detonated in Area 9 by the Lawrence Radiation Laboratory on May 19, 1962 at 0800 hours PDT. Winds from the south carried the cloud north of Ground Zero to cross Highway 25 between Diablo and Queen City Summit. Weather observations at H-hour indicated a temperature inversion at 11,000 feet MSL and showed a maximum wind directional shear of 38 degrees within the mixing layer. Meteorological conditions, coupled with terrain influences, were effective in distributing the cloud activity in a long narrow pattern over the valley north of Nyala. The most distant point from Ground Zero at which the cloud was monitored was on Highway 50 between Ely and Eureka. The highest dose rate readings there were 0.08 mr/hr at approximately H + 7 hours.

An aerial cloud tracking team and nine ground monitoring teams tracked the cloud and measured dose rates in the off-site area. Two dose rate recorders, nineteen air samplers with glass fiber filters, and seven air samplers having both filters and cartridges were operating in off-site locations for surveillance of Eel.

Aerial cloud tracking. The aerial team, in a U. S. Air Force U3-A aircraft, tracked the cloud from 0800 to 1050 hours, when rough weather made it necessary to end the mission. The first dose rates above background observed over the off-site area were detected five miles east of Queen City Summit, where the maximum dose rate was 5 mr/hr at 0924 hours. This reading was taken above the cloud at 11, 500 feet MSL. At 0935 hours, the cloud was penetrated ten miles north of Queen City Summit at an elevation of 8800 feet MSL. The dose rate was 10 mr/hr at this time.

At 1015 hours, a reading taken four miles northeast of Diablo at 11, 400 feet MSL was 7 mr/hr. Rough weather and uneven terrain encountered here was beginning to break up the cloud. At 1045 hours a reading of 6 mr/hr was observed ten miles northeast of Hot Creek Pond at 8000 feet MSL. Before terminating its mission, the aerial team remonitored Highway 25 from Diablo to the Valley Road Junction. Only background dose rates were detected.

Ground monitoring. Highest dose rate readings off site were taken during cloud passage in the vicinity of Queen City Summit on Highway 25. The maximum net gamma dose rate was 10 mr/hr at 0941 hours about six miles northwest of Queen City Summit. Dose rates above

1 mr/hr were observed until approximately 1120 hours from nine miles northwest to five miles southeast of the Summit. At Diablo, net gamma dose rate reached a maximum of 1.5 mr/hr at 1035 hours, and no readings above background were observed at Warm Springs.

On the road to Nyala, the highest net gamma dose rate observed was 3.0 mr/hr around 1105 hours, while at Nyala itself only very low readings were taken. Between Lockes and Currant on Highway 6, net gamma dose rates were less than 0.3 mr/hr. The highest reading taken at Currant was 0.10 mr/hr above background. All net gamma dose rates north of Currant were below 0.10 mr/hr with the exception of two slightly higher values observed on Highway 20 between 1340 and 1345 hours.

On May 20, the day following Eel, several roads were remonitored. Except for one value of 0.18 mr/hr taken near the test site boundary on the Kawich Road, all dose rates measured off site were 0.1 mr/hr or less above background. These monitoring data follow those taken on the nineteenth in Table 6 of Appendix A.

Dose rate recorders. The record taken between 0900 and 1635 hours on May 19 at Gunderson's Ranch showed the Eel cloud did not reach that location. A Gelman recorder (see 4.5 of Chapter 4) was set up at Currant at 1245 hours after peak cloud activity had passed. The highest net gamma dose rate on this record was 0.07 mr/hr between 1301 and 1304 hours. At 1445 hours when the record was stopped, the reading was about twice background, showing a net dose rate of 0.02 mr/hr.

Sampling. Air was sampled by glass fiber filters at nineteen off-site locations, and by both filters and cartridges at seven other locations. Analysis of filters showed gross beta activity was above background concentrations in air at Gunderson's Ranch, Tempiute, Diablo, and Currant.

The filter showing the highest concentration of gross beta activity in air had been sampling at Currant between 0705 and 2000 hours on May 19. Activity extrapolated to mid-point of this sampling period indicated a concentration of 3400 pc/M^3. Although dose rates above background had not been detected at Gunderson's Ranch, the air filter which sampled from 0900 to 1635 hours contained activity to indicate the average concentration of gross beta activity in air had been 1000 pc/M^3. Activity on this filter was also corrected for decay to mid-point of the sampling period.

Charcoal cartridges from Gunderson's Ranch, Diablo, and Currant contained measurable amounts of fresh fission products. The cartridge from Currant indicated highest iodine concentrations in air to have existed at Currant between 2000 hours on May 19 and 0645 hours the following morning. Average concentration of I-131 corrected for decay to mid-point of the sampling period was 5.6 pc/M^3.

Air sampling data collected for surveillance of the Eel event are presented in Table 6 of Appendix C.

Water samples were taken on May 19 from three sources in the off-site area. These were the Queen City Summit pond (43 miles from Ground Zero), a pond at Nyala (80 miles), and Hot Creek Pond (99 miles). None of these sources supply water for human consumption. Only the sample from the pond at Queen City Summit contained fresh fission products. Iodine isotopes of mass numbers 131, 133, and 135 were present in concentrations of 1.7, 24, and 35 pc/l. Seven and three tenths picocuries of Te^{132} were also detected per liter of water.

Grab samples of soil from Queen City Summit, from 7 miles west of Nyala, and from the vicinity of Lockes contained small amounts of I^{131}, I^{133}, and traces of Te^{132}. The Queen City Summit sample contained the highest concentration of each isotope. These isotopes were not detected from a soil sample collected from Diablo.

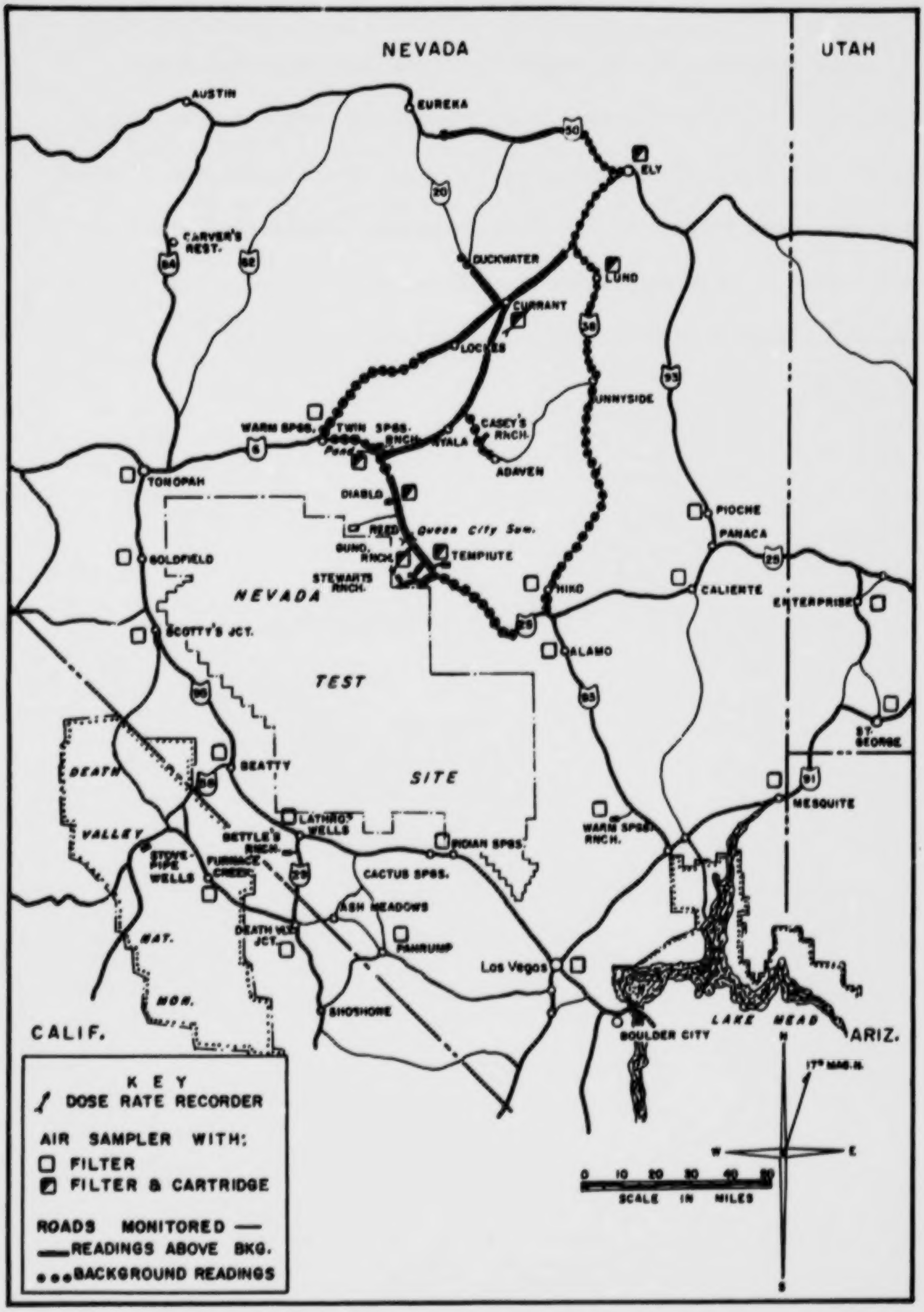

NEVADA
UTAH
AUSTIN
EUREKA
50
ELY
20
CARVER'S REST.
84
82
DUCKWATER
LUND
CURRANT
38
LOCKES
93
SUNNYSIDE
WARM SPGS.
TWIN SPGS. RNCH.
CASEY'S RNCH.
NYALA
ADAVEN
6
Pond
TONOPAH
DIABLO
PIOCHE
REED
Queen City Sum.
PANACA
GOLDFIELD
GUND. RNCH.
TEMPIUTE
25
STEWARTS RNCH.
HIKO
CALIENTE
NEVADA
ENTERPRISE
25
SCOTTY'S JCT.
ALAMO
TEST
95
93
ST. GEORGE
DEATH
BEATTY
SITE
91
MESQUITE
VALLEY
LATHROP WELLS
WARM SPGS. RNCH.
BETTLE'S RNCH.
INDIAN SPGS.
STOVE-PIPE WELLS
FURNACE CREEK
29
CACTUS SPGS.
ASH MEADOWS
NAT.
DEATH VLY. JCT.
PAHRUMP
Las Vegas
MON.
SHOSHONE
LAKE MEAD
CALIF.
BOULDER CITY
N
ARIZ.
17° MAG. N.
KEY
DOSE RATE RECORDER
AIR SAMPLER WITH:
FILTER
FILTER & CARTRIDGE
ROADS MONITORED —
READINGS ABOVE BKG.
BACKGROUND READINGS
W
E
S
0 10 20 30 40 50
SCALE IN MILES

Figure 5.3.6. Off-site surveillance locations for the Eel event on May 19, 1962.

Grab samples of desert vegetation were taken from the same locations. The same isotopes were identified on vegetation as in soil. Levels of activity, when corrected for decay to estimated time of cloud passage, were higher on vegetation, however. Again, the highest concentrations were in the sample from Queen City Summit. The vegetation sample from Diablo contained only a trace of I^{133}.

5.3.7 Des Moines

The thirty-eight event of Operation Nougat, and the last of the series to release radioactive material to the off-site area, took place on June 13, 1962 at 1400 hours PDT. This was Des Moines, a tunnel shot in Area 12 conducted by the Lawrence Radiation Laboratory.

Originally, a dense black cloud apparently containing both gaseous and particulate material formed over Ground Zero and was carried north by 35 mph winds. As it moved, its color changed to a light brown. By the time it entered the off-site area, between Reed and Gunderson's Ranch, its composition was almost entirely gaseous. This gaseous cloud moved rapidly north of the test site until it crossed Highway 50 between Ely and Eureka. There it appeared to slow down, since relatively higher levels of activity were detected in this area than at locations along the cloud trajectory closer to the test site. This effect may have been caused by night drainage winds moving against the winds prevailing during the day.

The aerial cloud tracking team and twelve ground monitoring teams followed the Des Moines cloud and measured dose rates in the off-site area. Seven dose rate recorders and twenty-six air samplers, six of them with both filters and cartridges, were operating at off-site locations. In addition, water samples were taken from five open and thirteen covered sources, and within sixteen days following Des Moines, milk samples were collected from ten off-site locations. Fallout trays, not previously used off site during Nougat, were set up at four locations. Several grab samples of vegetation were also collected.

Aerial cloud tracking. A U. S. Air Force U3-A aircraft and crew were again supplied to the PHS cloud tracking team. They first encountered the Des Moines cloud in the off-site area when its leading edge was about three miles south of a line between Reed and Gunderson's Ranch at 1510 hours. Ten minutes later, a reading of 300 mr/hr was taken at 10,000 feet MSL three miles northwest of the Ranch.

The cloud's leading edge reached Highway 25 at 1523 hours. Eight miles southeast of Queen City Summit dose rate measured in the plane was 50 mr/hr. Over the Summit at 1525 hours, dose rate was 100 mr/hr. At the cloud's trailing edge three miles southeast of Reed at 1535 hours, the dose rate was also 100 mr/hr.

As the body of the cloud passed over Queen City Summit at 1545 hours, it appeared to split. A small narrow arm followed Penoyer Valley and Quinn Canyon northeast toward Adaven. The main cloud continued north over the Quinn Canyon range, so that by 1600 hours the west edge of the cloud was over the center of the dry lake northeast of Diablo. At 1604 hours, a reading of 20 mr/hr was taken three miles south of Diablo at 10,000 feet MSL. At 1620, the main cloud extended from four miles south of Nyala on the north, to seven miles east of Nyala Road's junction with Highway 25 on the west. The trailing edge was twenty miles northeast of Queen City Summit at 1640 hours, where the dose rate was 10 mr/hr. Readings during this period and all those taken thereafter were made at an altitude of 10,000 feet MSL.

The eastern arm of the cloud was detected three miles south of Pine Creek Ranch at 1615 hours. At 1642 hours, the dose rate observed one half mile west of the Ranch was 30 mr/hr. Soon after this time the eastern arm joined the main cloud near Adaven.

The cloud's leading edge had moved over the dry lake between Lockes and Nyala by 1655 hours, and its trailing edge was between this lake and Nyala at 1705 hours. Dose rate in the aircraft was 50 mr/hr at this time. The same dose rate was detected over Nyala at 1707 hours.

Soon after this, low fuel and approaching darkness required the aerial team to end its mission. Before leaving the area, however, it assisted Net Control in positioning a ground monitor on Highway 6 in the center of the estimated cloud path.

Ground monitoring. Both gamma and beta plus gamma dose rates were extensively measured in the off-site area by ground monitoring teams. Dose rates off site were found to be generally higher after the Des Moines detonation than they had been after other events of Operation Nougat. This was probably more the result of the unusually high wind speeds than of any other contributing factor.

The highest reading observed after Des Moines, and also the highest of the Nougat series, was taken at Queen City Summit on Highway 25, thirty-seven miles from Ground Zero. There net gamma dose rate reached a peak of 160 mr/hr at 1527 hours and was greater than 100 mr/hr between 1525 and 1545 hours. The dose rate then dropped an order of magnitude to be 10 mr/hr at 1605 hours.

The highest net gamma dose rate detected at a residential location was 100 mr/hr. Two hours and fifty minutes after detonation this dose rate was observed at Nyala, seventy-five miles from Ground Zero. At 1703 hours, the dose rate there had dropped to 60 mr/hr, and one hour later was down to 8 mr/hr. The last dose rate recorded at Nyala on June 13 was 5 mr/hr at 1849 hours.

Other residential locations at which ground monitors measured dose rates above background were: Diablo, where the maximum net gamma dose rate was found to be 42 mr/hr at ground level at 1545 hours; Currant, where the dose rate was 11 mr/hr at 1820 hours and 2.5 mr/hr at 2032 hours; Duckwater, where 3.5 mr/hr above background was observed at 1849 hours; and Eureka, where a reading of 0.03 mr/hr above background was observed at 2018 hours. Monitors at Twin Springs Ranch and at Warm Springs ~~detected~~ no dose rates above background.

All dose rates measured by ground monitoring teams on June 13 are listed in Table 7 of Appendix A, and the map in Figure 5.3.7 illustrates the pattern of monitoring carried out on the day of the Des Moines event. It will be noted that few monitoring data are available for the area north of Highway 6. This is because few roads exist in that area, and the cloud was traveling too fast for effective cross-country tracking.

Dose rates taken in areas remonitored on June 14 are also given in Table 7 of Appendix A. Background dose rates were found at Tempiute, Warm Springs, Twin Springs Ranch, Pine Creek Ranch, and at Eureka. Low net gamma dose rates of 0.01 to 0.02 mr/hr were detected at Adaven and at Uhalde Ranch nearby between 1515 and 1530 hours. Higher net gamma dose rates were recorded at Diablo, Nyala, Lockes, Currant, Duckwater, Moorman Ranch, and Ely. The highest dose rate measured at any residential location on June 14 was 1 mr/hr at Currant at 1817 hours. All other dose rates detected at the locations listed were 0.9 mr/hr or less above background.

Dose rate recorders. Each of the seven dose rate recorders operating at off-site locations for surveillance of Des Moines provided recorders showing elevated dose rates.

At Reed, the record showed dose rates fluctuating to a maximum of 0.2 mr/hr between 1744 and 1909 hours. After 1920 hours the record showed only background dose rate. This recorder operated from 1520 to 2223 hours on June 13.

At Gunderson's Ranch, the only activity above background recorded between 1415 hours on June 13 and 1050 hours the next day occurred over a ten minute period beginning at 1941 hours on June 13. Peak dose rate was 0.14 mr/hr above background.

At Diablo, the record showed cloud arrival at 1537 hours on June 13. Dose rate fluctuated to a maximum of 60 mr/hr until 1602 hours, and then dropped steadily to 7 mr/hr by 1624 hours, and to 2 mr/hr by 1920 hours on June 14.

At Warm Springs, an unusual record was obtained. Activity above background was recorded over five discrete time intervals, and dose rate was constant during each one. The time intervals and net dose rates were: 1805 to 1836 hours - 0.04 mr/hr; 1947 to 2023 hours - 0.05 mr/hr; 2042 to 2044 hours - 0.06 mr/hr; 2204 to 2225 hours - 0.05 mr/hr; and, 2352 hours on June 13 to 0018 hours on June 14 - 0.04 mr/hr. It appeared that this unusual record was caused by monitors who parked their slightly contaminated vehicles near the recorder when they stopped at Warm Springs for food or gas.

At Currant, peak dose rate was recorded as 11 mr/hr at the time the record began early in the evening of June 13. Dose rate dropped rapidly from then until midnight to less than 2.5 mr/hr. Throughout June 14 it continued to drop, although at a slower rate, so that at midnight on June 14 dose rate was 0.5 mr/hr. The record thereafter showed a very gradual decrease in dose rate until background was reached around noon on June 17.

The record from a recorder located 9.8 miles northeast of Currant distinctly showed cloud arrival at H + 4 hours. From that time dose rate rose within less than an hour to a peak of 10 mr/hr. It then dropped rapidly within the next hour to less than 2.5 mr/hr. Between 2000 hours on June 13 and 0730 hours on June 14, dose rate dropped continuously to less than 1 mr/hr when the record stopped.

The recorder at Lockes also showed a distinct and rapid rise in dose rate beginning just before 1800 hours on June 13. The peak of 10 mr/hr was reached within a few minutes, and within an hour dose rate had dropped to less than 2 mr/hr. By noon on June 14, dose rate was about 0.2 mr/hr, after which it continued to drop slowly to reach 0.1 mr/hr when the recorder was stopped at 0700 hours the following morning.

The data from dose rate recorders supported that taken by ground monitoring teams except at Diablo. There, the recorder detected a peak dose rate of 60 mr/hr, while the monitor detected a peak of 42 mr/hr at ground level. The monitor's instruments were calibrated before the event and were checked for calibration after the event. Survey instruments generally maintained their calibration better than did the recorder-detector systems. Therefore, the monitor's measurements were probably the more accurate of those made at Diablo.

Sampling. Analysis of filters from air samplers at Gunderson's Ranch, Queen City Summit, Diablo, Warm Springs, Currant, Lund, and Eureka indicated that concentration of gross beta activity in air at those locations had been increased above background levels by the Des Moines cloud.

Activity collected on the filter from Queen City Summit between 1410 and 1910 hours on June 13 indicated a concentration in air much higher than that measured at any other off-site location. Analysis of this sample showed average concentration of gross beta activity was 15,000 pc/M^3 when corrected for decay to time of cloud passage at 1615 hours. Gamma pulse height analysis of the same filter showed 220,000 pc of I^{135}, 14,000 pc of I^{133}, 1300 pc of I^{131}, 3000 pc of Te^{132}, and over 200 pc of Ru^{103} and of Ba^{140}-La^{140} per cubic meter of air. The charcoal cartridge inserted behind this filter indicated an I^{135} concentration in air of 6400 pc/M^3. All isotopes found on the filter were also present in the cartridge, although in much smaller amounts.

The highest concentration of gross beta activity in air at a residential location was 5900 pc/M^3 at Diablo. Activity on the filter collecting between 0840 and 1925 hours was extrapolated to time of cloud passage to obtain this value. Gamma pulse height analysis of this filter showed that I^{135} was the predominant isotope with a concentration at cloud passage time of 20,000 pc/M^3. The charcoal catridge contained one-tenth that concentration of I^{135}. Both the filter and the cartridge from Diablo contained the same fission products as were identified in the samples from Queen City Summit.

A second air sampler, containing only a filter, was also operating at Diablo. This sampler collected airborne material over two 24-hour periods beginning at 0700 hours on June 13. Activity counted on these two filters was not corrected for decay, but was averaged over the 24-hour sampling period to yield average concentrations for June 13 of 217 pc/M^3 and for June 14 of 26 pc/M^3.

Data pertaining to all air samples which contained activity above normal levels are presented in Table 7 of Appendix C. In studying these data, the time to which sample activity was corrected for decay should be noted, since it varies between samples taken from a single location.

Fallout trays were set up at Gunderson's Ranch, Queen City Summit, Diablo, and Warm Springs. Fallout trays used by the Off-Site Radiological Safety Program were 8" x 10" aluminum plates coated on one side with a sticky, non-drying resin mixture. These plates were clipped, sticky side up, to a support plate which was in turn fastened horizontally on wooden posts to be three feet above ground level.

After exposure, each tray was removed from its support, placed in a glassine envelope on which exposure period was recorded, and carried to the laboratory for analysis. Gross beta activity on the trays was counted in a wide-area probe, and gamma emitters were measured by placing the trays on top of the 4" x 4" crystal of the crystal-analyzer system described in Chapter 4.

Gross beta activity was highest on the tray exposed at Diablo between 0830 and 1920 hours on June 13. Corrected for decay to time of peak cloud activity over Diablo, this tray collected 100 microcuries of gross beta activity per square meter. Fresh fission products identified on the tray were I^{131}, I^{133}, Te^{132}, Ru^{103}, and Ba^{140}-La^{140}. Of these, I^{133} was present in the greatest concentration of 4.7 $\mu c/M^2$. Tellurium-132 activity, the second most concentrated, was about a factor of seven lower.

The tray exposed at Queen City Summit between 1420 and 1700 hours contained gross beta activity of 55 $\mu c/M^2$ corrected to time of cloud passage. One-tenth microcurie of Ba^{140}-La^{140} was present per square meter, as were smaller amounts of I^{133} and Ru^{103}.

The tray exposed at Gunderson's Ranch from 1400 hours on June 13 to 1100 hours the next day showed gross beta activity of fallout at time of cloud passage to have been 0.52 $\mu c/M^2$. About half that concentration was measured on the tray from Warm Springs.

During surveillance of the Des Moines event, water samples were collected on June 14 from eighteen off-site sources. Location of these sources is listed below by name and by azimuth and distance from Ground Zero. Only the samples from the three open sources marked in the list with an asterisk (*) contained detectable concentration of fresh fission products.

Wells or Covered Springs

Tempiute (43°, 39 mi.)
Warm Springs (352°, 67 mi.)
Adaven (30°, 72 mi.)
Bordoli Ranch (24°, 78 mi.)
Rattlesnake (1°, 84 mi.)
Lockes (14°, 95 mi.)
Blue Eagle Ranch (21°, 100 mi.)
Sunnyside (37°, 106 mi.)
Currant (20°, 112 mi.)
Lund (30°, 130 mi.)
Eldorado (6°, 150 mi.)
Moorman Ranch (15°, 154 mi.)
Eureka (3°, 159 mi.)

Open Springs or Ponds

*Nyala (19°, 75 mi.)
Blue Eagle Ranch (21°, 97 mi.)
*Currant (20°, 112 mi.)
*Ranch near Duckwater (15°, 116 mi.)
17 mi. S of Hwy. 50 (7°, 134 mi.)

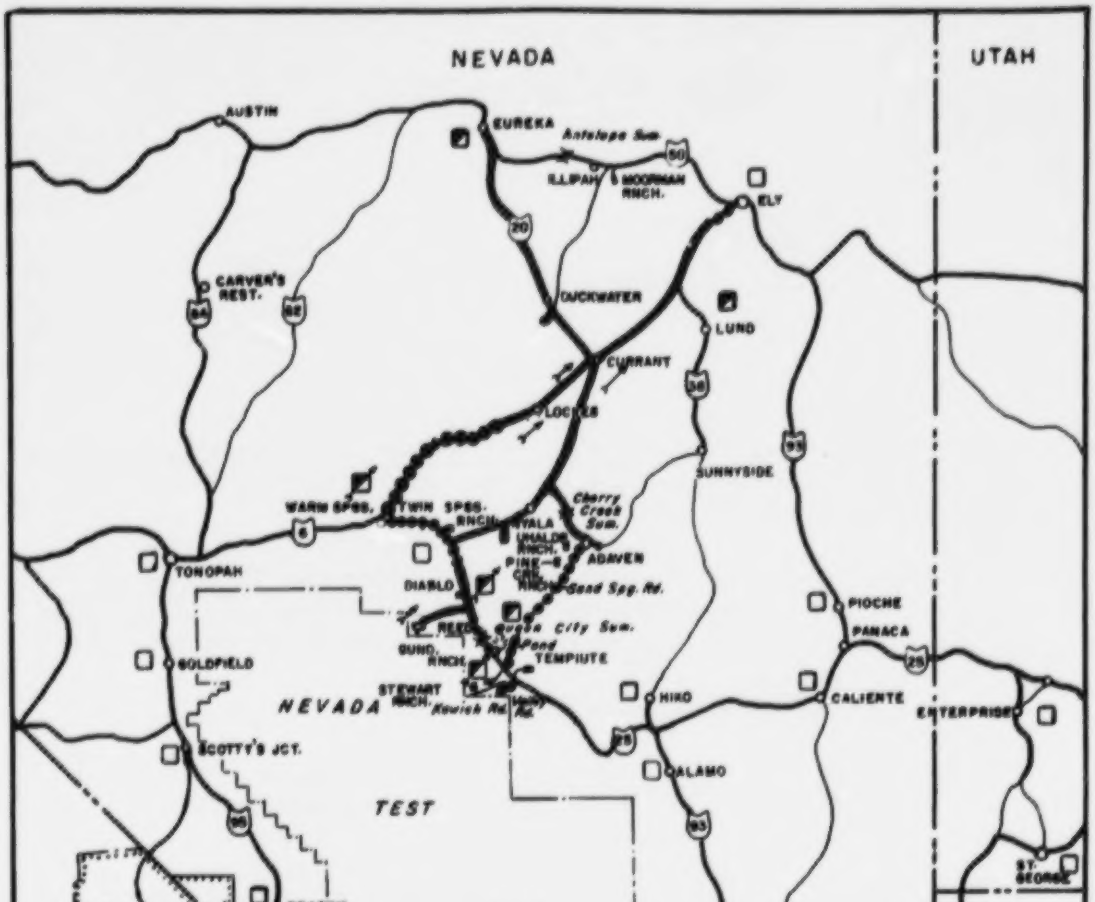
When activity was corrected for decay to estimated time of peak cloud activity over the source, the following results were obtained: the water sample from Nyala contained, at 1650 hours, 2400 pc I^{131}, 31,000 pc I^{133}, and 36,000 pc Te^{132} per liter; the one from Currant contained, at 1830 hours -- 4200 pc I^{133}, and no detectable I^{131} or Te^{132} per liter; the one from the ranch near Duckwater contained, at 1825 hours -- 9000 pc I^{133}, 3900 pc Te^{132}, and no detectable I^{131} per liter. It should be noted that these water samples were from open springs or ponds, and that no activity was detected in any sample from a covered spring or well.

Data from analysis of the ten milk samples collected after the Des Moines event from off-site locations north of the test site are shown in Table 5.3.7. The highest I^{131} concentration was found in the sample collected from Elko, Nevada one week after the Des Moines detonation. Concentration of Cs^{137}, Sr^{89}, and Sr^{90} were also highest in the Elko sample.

Several fresh fission products were identified in the grab samples of vegetation taken from twenty-three off-site locations on June 13 and 14. As would be expected, activity levels of I^{133} and I^{135} were distinctly higher than those of I^{131}. Relatively higher levels of gamma activity were found in samples from Queen City Summit, the road to Nyala, and from the vicinity of Currant than were seen at Warm Springs, Sunnyside, Lund, Eureka, or other locations to either side of the cloud trajectory. In general, the vegetation sample data indicated the same dispersion pattern of cloud activity as was determined from air sampling and ground monitoring data.

Table 5.3.7. Data from milk samples collected for surveillance of Des Moines.

Location (Az. & Dist. from GZ)	Date Collected	Activity (pc/l at collection				gm/l	
		I^{131}	Cs^{137}	Sr^{89}	Sr^{90}	K	Ca
Adaven (30°, 72 mi.)	6/20	360	75	35	10	1.3	1.27
Blue Eagle Ranch (21°, 97 mi.)	6/13	20	180	60	13	1.4	1.28
White River Val. R. (22°, 135 mi.)	6/13	40	80	60	15	1.5	1.27
Austin (342°, 166 mi.)	6/30	180	75	65	13	1.8	1.19
Robbins Ranch (23°, 216 mi.)	6/22	520	140	40	5	1.5	1.00
Battle Mountain (350°, 243 mi.)	6/28	50	15	190	21	1.9	1.18
Carlin (1°, 243 mi.)	6/22	160	120	50	9	1.1	1.22
Elko (5°, 254 mi.)	6/21	610	200	230	38	1.3	1.22
Wells (13°, 280 mi.)	6/23	80	110	135	22	1.4	1.22
20 miles N of Wendover, Utah (23°, 294 mi.)	6/29	94	25	55	8	2.0	1.02


NEVADA
UTAH
AUSTIN
EUREKA
Antelope Sum.
50
ELLIPAH
MOORMAN RNCH.
ELY
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CARVER'S REST.
84
82
DUCKWATER
LUND
CURRANT
38
LOCKES
SUNNYSIDE
93
WARM SPGS.
TWIN SPGS. RNCH.
6
NYALA
UHALDE RNCH.
Cherry Creek Sum.
ADAVEN
TONOPAH
PINE CRK. RNCH.
DIABLO
Sand Spg. Rd.
REED
Queen City Sum.
Pond
GUND. RNCH.
TEMPIUTE
PIOCHE
PANACA
25
GOLDFIELD
STEWART RNCH.
Kawich Rd.
Hiko Rd.
NEVADA
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LAKE MEAD
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FILTER
FILTER & CARTRIDGE
ROADS MONITORED —
READINGS ABOVE BKG.
BACKGROUND READINGS
0
10
20
30
40
50
SCALE IN MILES

Figure 5.3.7. Off-site surveillance locations for the Des Moines event on June 13, 1962.

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APPENDIX A

DOSE RATES MEASURED OFF SITE FOR SURVEILLANCE OF SEVEN EVENTS OF OPERATION NOUGAT

Table No. Page

Table 1. Dose rates measured off site during surveillance of the Antler event. A- 1

Table 2. Dose rates measured off site during surveillance of the Feather event. A- 3

Table 3. Dose rates measured off site during surveillance of the Pampas event. A- 6

Table 4. Dose rates measured off site during surveillance of the Danny Boy event. A-10

Table 5. Dose rates measured off site during surveillance of the Platte event. A-15

Table 6. Dose rates measured off site during surveillance of the Eel event. A-23

Table 7. Dose rates measured off site during surveillance of the Des Moines event. A-30

Notes

Azimuth and distance in tables of dose rate measurements are given with respect to the Ground Zero of each event.

Dates on which dose rates were measured precede the data. Data taken on different days are separated by a double line.

The time at which a dose rate was measured is always in the column heading as the prevailing local clock time.

Table 1. Dose rates measured off site during surveillance of the Antler event.

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr)	
				γ	β + γ
		Approaching Reed from the S on the road from Kawich Lake	9/15/61		
5	38	2.8 mi.	1148	0.12	
		2.7 mi. (from Reed)	1150	1.5	
		"	1151	0.7	
	39	1.7 mi.	1154	1.7	
		1.2 mi.	1156	1.9	
		At Reed			
6	41		1100	Zero	
			1200	1.0	
			1201	1.0	
			1203	1.5	
			1205	1.8	
		(on vegetation)	1410	0.2	
		N of Reed on the road to Diablo			
6	42	2 mi.	1208	0.58	
	44	3 mi. (from Reed)	1210	0.10	
	45	4 mi.	1213	0.05	
		"	1215	0.07	
	49	8 mi.	1220	0.02	
		"	1223	0.04	
		"	1225	0.12	
		"	1226	0.08	
7	54	12 mi.	1227	0.06	
65-9	44-47	52 miles SE of Diablo to 5 miles S of Diablo on Hwy. 25 (7 readings)	1100-1310	All Zero	
		Approaching Diablo from the S on Hwy. 25			
9	49	4 mi.	1450	0.04	
8	50	3 mi. (from Diablo)	1315	0.02	
		"	1448	0.03	
	51	2 mi.	1445	0.07	
	52	1 mi.	1443	0.12	
		At Diablo			
8	53		1243	0.10	
			1319	0.02	
			1440	0.10	
		Going N of Diablo on Hwy. 25 toward Twin Springs Ranch			
8	54	1 mi.	1443	0.10	
	55	2 mi. (from Diablo)	1325	0.03	
		"	1328	0.17	
		"	1330	0.27	
		"	1445	0.10	
7	56	3 mi.	1335	0.27	
		"	1447	0.10	
	57	4 mi.	1450	0.08	
6	58	5 mi.	1453	0.09	
		"	1640	0.07	

Table 1. Dose rates measured off site during surveillance of the Antler event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr)	
				γ	β + γ
		Going N of Diablo on Hwy. 25 toward Twin Springs Ranch (Cont.)			
6	59	6 mi.	1455	0.09	
	60	7 mi. (from Diablo)	1457	0.08	
	61	8 mi.	1345	0.27	
		"	1500	0.08	
	63	10 mi.	1252	0.08	
5	66	13 mi.	1350	0.37	
	67	14 mi.	1300	0.33	
3	68	16 mi.	1355	0.47	
	69	17.1 mi.	1305	0.48	
2		17.5 mi.	1306	0.7	
1	71	19 mi.	1309	0.6	
		"	1400	0.6	
0	72	20 mi.	1402	0.8	
		20.5 mi.	1311	1.2	
		21 mi.	1403	1.0	
359		21.5 mi.	1313	4.4	
		22 mi.	1315	10	
		At Twin Springs Ranch			
1	71		1317	12.5	
			1405	1.2	
			1620	0.04	
		Going W of Twin Springs Ranch toward Warm Springs on Hwy. 25			
1	73	1.1 mi.	1320	11.5	
0	72	2 mi. (from Twin	1445	0.47	
359		2.6 mi. Springs Ranch)	1323	13	
		3.6 mi.	1325	11.5	
357		6 mi.	1450	0.27	
356		6.6 mi.	1330	3.8	
		7.1 mi.	1333	1.6	
355		7.6 mi.	1337	0.4	
354		9.1 mi.	1340	0.28	
		At Warm Springs			
353	72		1342	0.28	
			1500	0.17	
			1610	Zero	
		NE of Warm Springs on Hwy. 6 going toward Lockes			
353	72	0.2 mi.	1352	0.7	
355	75	4.2 mi. (from Warm	1358	0.7	
356	78	7.1 mi. Springs)	1445	0.23	
357	80	10.1 mi.	1442	0.38	
358	81	11.2 mi.	1407	1.0	
359	83	13.2 mi.	1410	1.1	
	84	14.1 mi.	1437	0.4	
0	85	16.3 mi.	1413	1.5	
	86	17.1 mi.	1432	0.75	
1	90	21.1 mi.	1427	0.6	

Table 2. Dose rates measured off site during surveillance of the Feather event.

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	$\beta + \gamma$
			12/22/61		
37	38	At Gunderson's Ranch in Penoyer Valley	1010	Zero	
162- 233	37- 64	Mercury to Stovepipe Wells on Hwy. 95 and Route 58	1130- 1325	All Zero	
197- 240	37- 35	Lathrop Wells to Beatty on Hwy. 95	1033- 1125	All Zero	
240- 173	35- 42	On Hwy. 95 from Beatty to 18 miles E of Lathrop Wells	1125- 1213	All Zero	
197	37	At Lathrop Wells	1550	0.02	
		On Hwy. 95, going W from Lathrop Wells toward Beatty			
211	38	9.5 mi.	1530	0.01	
212		10 mi. (from Lathrop Wells)	1500	0.05	
213		11 mi.	1455	0.05	
215		12 mi.	1450	0.04	
216		13 mi.	1446	0.05	
218		14 mi.	1404	0.01	
		"	1444	0.06	
219		15 mi.	1400	0.01	
		"	1405	0.02	
		"	1442	0.06	
		15.1 mi.	1300	0.03	
220		15.5 mi.	1357	0.02	
		15.7 mi.	1257	0.02	
		"	1258	0.03	
221		16 mi.	1220	0.01	
		"	1255	0.02	
		"	1355	0.04	
		"	1406	0.04	
		"	1440	0.03	
222		16.5 mi.	1350	0.06	
223		17 mi.	1223	0.02	
		"	1310	0.02	
		"	1315	0.02	
		"	1320	0.04	
		"	1330	0.05	
		"	1335	0.06	
		"	1343	0.05	
		"	1413	0.03	
		"	1435	0.02	
		17.4 mi.	1340	0.04	
		17.5 mi.	1215	0.01	

Table 2. Dose rates measured off site during surveillance of the Feather event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr) γ	β + γ
		On Hwy. 95, going W from Lathrop Wells toward Beatty (Cont.)			
224	38	17.9 mi.	1220	0.01	
		18 mi. (from Lathrop Wells)	1220	0.01	
		"	1224	0.01	
		"	1247	0.02	
		"	1335	0.02	
		"	1417	0.03	
225		18.4 mi.	1225	0.01	
		18.5 mi.	1331	0.03	
		19 mi. (8 readings)	1220-1240	0.01	
		19 mi. (1 reading)	1307	0.06	
		"	1329	0.02	
		"	1420	0.02	
226		19.4 mi.	1309	0.01	
		19.5 mi.	1302	0.01	
		"	1327	0.01	
		"	1515	0.01	
227		19.8 mi.	1310	0.01	
		20 mi.	1300	0.01	
		"	1325	0.01	
		20.2 mi.	1312	0.01	
228		20.3 mi.	1234	0.01	
		20.5 mi.	1323	0.01	
229		20.7 mi.	1315	0.01	
229-233	38-37	20.9-23.7 mi. (10 readings)	1255-1320	All Zero	
198	42	7 miles E of Bettle's Farm	1508	0.05	
202	48	At Bettle's Farm off Route 29	1535	0.06	
			1624	0.03	
			1640	0.03	
			1700	0.01	
209	45	5 miles N of Bettle's Farm	1554	0.03	
215	60	At Furnace Creek (3 readings)	1300-1530	All Zero	
219	57	5 miles NW of Furnace Creek	1440	Zero	
233	64	At Stovepipe Wells (5 readings)	1325-1415	All Zero	

Table 2. Dose rates measured off site during surveillance of the Feather event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	β + γ
		On Route 29, approaching Death Valley Jct. from the N			
193	54	7.3 mi.	1615	Zero	
192	55	6 mi. (from Death Valley Jct.)	1650	0.03	
191	58	3 mi.	1700	0.02	
190	60	At Death Valley Jct.	1158	Zero	
			1610	0.03	
			1611	0.08	
			1619	0.01	
			1635	0.02	
190-186	60-55	Going from Death Valley Jct. to Ash Meadows	1617	Zero	
		Approaching Death Valley Jct. from the W			
200	61	10 mi.	1415	Zero	
194		3.9 mi. (from Death Valley Jct.)	1600	Zero	
193		3 mi.	1608	0.01	
		2.5 mi.	1610	0.02	
192	60	2 mi.	1600	0.08	
		"	1612	0.02	
192-190	60	Between Death Valley Jct. and 1.5 miles W of Death Valley Jct.	1613-1617	0.01	
		Going S of Death Valley Jct. toward Shoshone			
190	62	1 mi.	1645	0.01	
	63	2 mi. (from Death Valley Jct.)	1647	0.01	
190-185	64-70	3-11.6 mi.	1649-1705	All Zero	
			12/23/61		
240	35	At Beatty	0715	Zero	
233	64	At Stovepipe Wells	0820	Zero	

Table 3. Dose rates measured off site during surveillance of the Pampas event.

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr) γ	β + γ
			3/1/62		
		On Valley Road, NE of the Gunnery Range Boundary			
23	41	1.8 mi.	1519	.07	
22		.9 mi. (from Boundary)	1520	.09	
		At Stewart's Ranch			
21	42		1525	.07	
			1530	.03	
			1546	.01	
		At the Jct. of Valley Road and Hwy. 25			
25	43		1525	.01	
			1540	.02	
			1555	.01	
			1620	Zero	
			2025	Zero	
		At Tempiute (6 readings)			
24	44		1532-1730	All Zero	
		At Coyote Summit			
28	42		1535	Zero	
		Coyote Summit to Hiko and Return			
28-47	42-58	(9 readings)	1535-1710	All Zero	
		On Hwy. 25 going NW from the Valley Road Jct.			
18	45	5.2 mi.	1550	.01	
17	46	6.5 mi. (from Jct.)	1456	Zero	
16		7.4 mi. (2 readings)	1525	.08	
		"	1553	.09	
		"	1602	.05	
		"	1603	.05	
		"	1735	Zero	
15		8.9 mi.	1555	.12	
13	47	10.5 mi.	1510	.02	
		" (3 readings)	1516-1526	All .07	
12		11.5 mi.	1529	.08	
		11.6 mi.	1607	.08	
11		12 mi.	1605	.10	
		12.2 mi.	1608	.09	
		12.3 mi.	1620	.03	
		12.4 mi.	1600	.07	
		12.5 mi. (2 readings)	1531-1535	.08	
9	48	13.6 mi. (2 readings)	1537-1540	.06	

Table 3. Dose rates measured off site during surveillance of the Pampas event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	β + γ
		On Hwy. 25 going NW from the Valley Road Jct. (Cont.)			
8	48	14.6 mi.	1542	.03	
7	49	At Queen City Summit	1530	.04	
			1545	.03	
			1549	.04	
			1553	.07	
			1558	.04	
			1601	.17	
			1609	.07	
			1610	.07	
			1610	.10	
			1610	.09	
			1615	.08	
			1615	.13	
			1618	.08	
			1628	.03	
			1630	.03	
			1633	.04	
			1635	.03	
			1640	.02	
			1645	.01	
			1650	Zero	
			1650	Zero	
			1725	Zero	
		On Hwy. 25 NW of Queen City Summit			
7	49	.1 mi.	1535	.04	
		.5 mi. (from Queen City Summit)	1540	.03	
	50	1.1 mi.	1542	.03	
6		1.8 mi.	1544	.02	
		2.3 mi.	1545	.02	
		"	1547	.02	
		"	1550	.02	
		"	1600	.07	
5		3.1 mi.	1605	.05	
	51	3.6 mi.	1606	.04	
		"	1610	.04	
3	52	5.8 mi.	1620	Zero	
358	58	13 mi.	1647	.02	
		"	1649	.07	
		"	1655	Zero	
358	62	At Diablo (4 readings)	1620-1645	All Zero	
			1652	.01	
			1655	.02	
			1656	.02	
			1657	.03	
			1700	.05	
			1702	.04	

Table 3. Dose rates measured off site during surveillance of the Pampas event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr) γ	β + γ
358	62	At Diablo (Cont.)	1704	.07	
			1706	.07	
			1708	.08	
			1714	.06	
			1718	.05	
			1725	.02	
			1730	.01	
		(3 readings)	1740- 1750	All Zero	
358- 25	62- 43	On Hwy. 25 from Diablo to Valley Road Jct.	1740- approx. 1820	All Zero	
		N of Hwy. 25 on Sand Springs Road			
16	50	4.3 mi.	1627	.01	
15	52	6.3 mi. (from Hwy. 25)	1630	.02	
	53	7.3 mi.	1632	.02	
14	54	8.3 mi.	1634	.02	
		9.3 mi.	1636	.02	
	55	9.5 mi.	1637	.02	
		10.1 mi.	1638	.02	
13	56	11.1 mi.	1640	.02	
	57	12.1 mi.	1641	.02	
	58	13.1 mi.	1643	.02	
	59	14.1 mi.	1645	.03	
	60	15.1 mi.	1646	.04	
12	61	16.1 mi.	1648	.06	
	62	17.1 mi.	1650	.08	
	63	18.1 mi.	1655	.07	
		18.3 mi.	1700	.03	
13	60	15.1 mi.	1730	.03	
16	43	At Gunderson's Ranch in Penoyer Valley	1250	Zero	
			1330	.01	
			1430	.01	
			1447	.02	
			1450	.02	
		(3 readings)	1452- 1455	All .01	
		(3 readings)	1456- 1458	All .02	
			1459	.03	
			1500	.03	
			1500	.06	
			1501	.08	
			1501	.10	
			1502	.12	
			1503	.14	
			1505	.08	
			1507	.10	

Table 3. Dose rates measured off site during surveillance of the Pampas event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	β + γ
		At Gunderson's Ranch in Penoyer Valley			
16	43		1508	.12	
			1509	.13	
			1510	.11	
			1511	.13	
			1513	.07	
			1514	.04	
			1515	.03	
			1516	.02	
			1520	.02	
			1527	.03	
			1530	.04	
			1531	.07	
			1532	.10	
			1533	.13	
			1535	.15	
			1536	.15	
			1537	.13	
			1539	.12	
			1540	.14	
			1540	.15	
			1540	.17	
			1540	.18	
			1541	.19	
			1542	.20	
			1543	.20	
			1544	.21	
			1544	.22	
			1545	.20	
			1546	.18	
			1550	.18	
			1552	.17	
			1555	.15	
			1557	.08	
			1558	.05	
			1600	.04	
			1602	.03	
		(4 readings)	1607-1620	All .02	
			1625	.04	
		(8 readings)	1630-1715	All .03	
		(4 readings)	1730-1745	All .01	

Table 4. Dose rates measured off site during surveillance of the Danny Boy event.

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	β + γ
			3/5/62		
		At Goldfield			
310	63		1230-1430	All Zero	
		At Clarks Station			
348	72		1415-1420	0.12	
			1425	0.13	
			1430	0.14	
			1435	0.16	
			1440	0.17	
			1445	0.16	
			1450-1505	0.14	
			1510	0.12	
			1515	0.10	
			1520-1525	0.09	
			1530	0.08	
			1535	0.10	
			1540	0.12	
			1545-1550	0.10	
			1555-1605	0.13	
			1610-1615	0.12	
			1620-1710	0.10	
		On Hwy. 6 W of Warm Springs			
358	72	2.3 mi.	1503	0.08	
		3 mi. (from Warm Springs)	1349	0.64	
		3.3 mi.	1502	0.09	
357		4.3 mi.	1501	0.10	
		5 mi.	1225	Zero	
		5.3 mi.	1500	0.11	
356		5.6 mi.	1340	1.3	
355		6.3 mi.	1459	0.12	
		6.6 mi.	1342	0.78	
353		7.3 mi.	1458	0.14	
354		8 mi.	1353	0.79	
		8.3 mi.	1345	0.37	
		"	1457	0.16	
		8.7 mi.	1230	0.37	
		9.3 mi.	1456	0.36	
352		10.3 mi.	1455	0.39	
351		11 mi.	1236	0.79	
		11.3 mi.	1453	0.34	
350		11.8 mi.	1350	0.37	

Table 4. Dose rates measured off site during surveillance of the Danny Boy event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	β + γ
		On Hwy. 6 W of Warm Springs (Cont.)			
350	72	11.8 mi.	1356	0.04	
		12 mi. (from Warm Springs)	1239	2.0	
		12.3 mi.	1450	0.24	
349		13.3 mi.	1447	0.20	
		14 mi.	1241	2.0	
		14 mi.	1317	0.02	
		14.3 mi.	1446	0.23	
		14.4 mi.	1355	0.27	
348		15.3 mi.	1400	0.10	
		16 mi.	1314	0.12	
347		16.5 mi.	1405	0.17	
		17 mi.	1320	0.08	
		"	1244	3.0	
345		17.7 mi.	1246	3.2	
		18 mi.	1248	0.88	
344		19 mi.	1255	Zero	
	73	20 mi.	1258	Zero	
342	72	22 mi.	1300	Zero	
		At Warm Springs			
360	74		1215	Zero	
			1325	0.47	
			1326	0.05	
			1335	0.34	
			1347	0.34	
			1506	0.06	
		On Hwy. 25 E of Warm Springs			
360	74	1.5 mi.	1324	0.47	
		2 mi. (from Warm Springs)	1330	0.24	
		"	1331	0.29	
2		2.7 mi.	1322	Zero *	
		"	1322	0.07 *	
		3 mi.	1328	0.14	
3		4 mi.	1325	0.07	
		On Hwy. 6 NE of Warm Springs			
0	75	1.1 mi.	1328	0.72	
		" (from Warm Springs)	1440	0.37	
		"	1445	0.32	
		"	1520	0.17	
		"	1532	0.04	
		"	1540	Zero	

*These two readings taken with different instruments by different monitors.

Table 4. Dose rates measured off site during surveillance of the Danny Boy event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME	DOSE RATE (net mr/hr)	
			PST	γ	β + γ
		On Hwy. 6 NE of Warm Springs (Cont.)			
1	76	2 mi.	1345	0.29	
		2.4 mi. (from Warm Springs)	1437	0.42	
2	78	4.3 mi.	1335	0.47*	
		"	1335	2.0*	
		"	1434	0.32	
	79	6.3 mi.	1337	0.32	
3	80	8 mi.	1340	0.17	
		"	1403	0.22	
		"	1423	0.27	
	82	9.9 mi.	1400	0.17	
4	84	11.8 mi.	1346	0.04	
	85	12.9 mi.	1350	Zero	
		On Hwy. 6, from Tonopah to 13 miles E of Tonopah			
324-332	80-74		1304-1337	All Zero	
		On Route 8A from Tonopah to Carver's Restaurant			
324-339	80-121		1145-1230	All Zero	
		NW of Hwy. 6, on the road to Tybo			
2	82	1 mi. (from the Jct. of	1410	0.32	
	83	1.7 mi. Tybo Rd. and Hwy. 6)	1417	0.22	
		On Route 8A, going from the Jct. of Hwy. 6 and Route 8A to the Jct. of Routes 8A and 82			
328-335	77-87		1428-1450	All Zero	
			1430-1500	All Zero	
			1448-1501	All Zero	
		From the Jct. of Routes 8A and 82 to Belmont			
333-344	88-105		1450-1530	All Zero	

*These two readings taken with different instruments by different monitors.

Table 4. Dose rates measured off site during surveillance of the Danny Boy event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr) γ	$\beta + \gamma$
333-341	88-100	18 miles NE of the Jct. of Routes 8A & 82	1500-1530	All Zero	
344-347	105 105	On Route 82, from Belmont to Monitor Valley	1530-1600	All Zero	
336	110	At Manhattan Jct.	1444	Zero	
339	121	At Carver's Restaurant on Route 8A	1350 1355-1400 1405-1415 1420 1500-1600	Zero 0.01 0.02 0.01 All Zero	
339-342	121-115	Carver's Restaurant to Round Mounta'	1230-1310 1420-1430	All Zero All Zero	
340	116	At Round Mountain	1310-1330	All Zero	
340	96-121	On Route 8A, going N from Manhattan Jct. to Carver's Restaurant	1444-1500	All Zero	
349-335	183-80	From the Jct. of Hwy. 50 & Route 8A to Tonopah	1635-1800	All Zero	
335-150	80-19	On Hwy. 95, from Tonopah to Mercury Turn-off	1800-2200	All Zero	
			3/6/62		
348	72	At Clarks Station	1200	0.02	
350	75 76	N of Clarks Station 3 mi. 4 mi. (from Clarks 5 mi. Station)	1230 1231 1235	0.02 0.04 0.07	
349					
349	77	At Stone Cabin Ranch	1240	0.08	

Table 4. Dose rates measured off site during surveillance of the Danny Boy event. (cont'd)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	β + γ
		SW of Stone Cabin Ranch			
346	73	6 mi. (from Stone	1410	0.01	
344		7 mi. Cabin Ranch)	1412	0.01	
343-339	73-121	On Hwy. 6 & Route 8A from 2 miles W of Stone Cabin Ranch Jct. to Carver's Restaurant	1415-1610	All Zero	

Table 5. Dose rates measured off site during surveillance of the Platte event.

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	β + γ
			4/14/62		
		On Valley Road, N of the Gunnery Range Boundary			
32	31	.1 mi.	1410	0.02	
		.3 mi. (from Boundary)	1140	Zero	
		"	1145	0.01	
	32	.5 mi.	1411	0.04	
36	33	3.1 mi.	1416	0.01	
42	36	12.6 mi.	1439	0.02	
36	33	At Kawich Valley Turn-off	1215	1.5	
		On Valley Road, W of Kawich Valley Turn-off			
36	33	.3 mi.	1217	1.5	
35		.7 mi. (from Turn-off)	1220	3.0	
		.8 mi.	1225	5.0	
34	36	At Gunderson's Ranch in Penoyer Valley (8 readings)	1030-1210	All Zero	
			1215	0.03	
			1218	0.09	
			1220	0.19	
			1222	1.5	
			1224	0.25	
			1228	0.08	
			1232	0.30	
			1235	0.03	
			1240	0.03	
			1245	0.16	
			1250	0.41	
			1255	1.0	
			1300	0.09	
			1345	0.02	
			1400	0.35	
			1410	0.01	
			1420	0.01	
			1430	0.02	
			1440	0.06	
			1500	0.09	
			1505	0.09	
			1515	0.05	
			1520	0.05	
			1540	0.14	
			1600	0.03	
			1715	Zero	
			1743	Zero	
21	40	At Queen City Summit (3 readings)	1005-1100	All Zero	
			1217	1.6	
			1220	1.4	

Table 5. Dose rates measured off site during surveillance of the Platte event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	β + γ
		At Queen City Summit (Cont.)			
21	40		1244	42	
			1251	47	
			1330	6	
			1447	1.3	
			1458	0.5	
			1550	1.1	
			1600	1.9	
			1723	0.7	
		On Hwy. 25, going SE from Queen City Summit			
22	39	.5 mi.	1252	45	65
		.8 mi. (from Queen City	1436	0.05	13
		1 mi. Summit)	1254	45	68
		"	1450	1.5	
23		1.5 mi.	1257	45	70
		2 mi.	1259	42	61
		"	1451	1.2	
		"	1522	0.5	
		2.5 mi.	1303	32	55
24		2.8 mi.	1434	1.0	
		3 mi.	1304	30	50
		"	1453	1.2	
		"	1527	0.3	
		"	1645	0.05	
		3.5 mi.	1306	22	42
25		4 mi.	1308	18	36
		"	1325	2.8	4.3
		"	1335	0.2	
		"	1415	Zero	
		"	1455	0.9	
		"	1500	0.9	
		"	1645	0.05	
		4.5 mi.	1310	12	24
26		4.8 mi.	1432	0.4	
		5 mi.	1312	8	22
		"	1330	0.6	1.4
		"	1338	Zero	
		5.5 mi.	1314	9	15
		"	1527	0.05	
27		5.8 mi.	1431	0.1	
28		6 mi.	1315	7	14
		"	1335	0.6	1.0
		"	1444	Zero	0.05
29		6.5 mi.	1317	2	11
		"	1320	7	14
30		6.8 mi.	1430	Zero	
		7 mi.	1430	0.6	1.0
		7.1 mi.	1312	0.90	
		"	1315	0.05	
32		8 mi.	1432	0.6	1.0
33		9 mi.	1434	0.05	0.3
34		10 mi.	1427	0.16	
		"	1437	0.05	0.1

Table 5. Dose rates measured off site during surveillance of the Platte event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	β + γ
		On Hwy. 25, going SE from Queen City Summit (Cont.)			
34	39	10 mi.	1440	0.05	0.1
		" (from Queen	1524	0.6	
		10.2 mi. City Summit)	1347	Zero	
36		11 mi.	1345	Zero	
38		12 mi.	1315	Zero	
		"	1343	Zero	
40		13 mi.	1342	Zero	0.05
		"	1446	Zero	
41		14 mi.	1340	Zero	
		"	1410	Zero	
		"	1444	0.11	
		"	1445	0.09	
		"	1448	Zero	
		"	1635	0.02	
		"	1635	0.02	
42		15 mi.	1450	Zero	Zero
44	38	16 mi.	1453	Zero	Zero
		"	1453	Zero	Zero
		At Coyote Summit			
46	38	(3 readings)	1455- 1505	All Zero	All Zero
		On Hwy. 25, 7 miles SE of Coyote Summit			
57	39		1510	Zero	
		On Hwy. 25, going NW from Queen City Summit			
20	40	1 mi.	1500	Zero	
14	42	5.4 mi. (from Queen	1712	0.7	
		5.5 mi. City Summit)	1215	0.09	
12		6.5 mi.	1217	0.34	
10	43	7.5 mi.	1219	0.03	
		"	1708	0.6	
		At Diablo			
7	51		1100	Zero	
			1145	Zero	
			1225	Zero	
			1230	Zero	
			1231	0.01	
			1234	0.09	
			1235	0.3	
			1236	0.5	
			1237	0.7	
			1238	1.0	
			1239	1.0	
			1243	0.7	
			1244	1.5	
			1245	1.6	
			1246	0.9	
			1247	1.4	

Table 5. Dose rates measured off site during surveillance of the Platte event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr) γ	DOSE RATE (net mr/hr) $\beta + \gamma$
		At Diablo (Cont.)			
7	51		1248	1.8	
			1252	1.9	
			1254	2.0	
			1258	1.5	
			1301	0.8	
			1305	1.4	
			1307	1.6	
			1308	3.0	
			1309	3.5	
			1310	4.0	
			1311	4.9	
			1314	7.0	
			1317	3.5	
			1320	2.0	
			1322	1.5	
			1329	1.2	
			1333	1.2	
			1338	1.1	
			1342	1.0	
			1347	1.2	
			1355	1.2	
			1400	1.2	
			1410	1.0	
			1415	0.2	
			1650	1.5	
		On Hwy. 25, N of Diablo			
5	60	10 mi.	1420	0.5	
0	69	22 mi.	1430	Zero	
		At the Jct. of Hwy. 25 & the road to Nyala			
3	66		1420	0.28	
			1425	0.13	
			1435	0.04	
0	69	At Twin Springs Ranch (13 readings)	1140-1430	All Zero	
		At Warm Springs			
351	71		1100	Zero	
			1500	Zero	
		On the road to Queen City Pond, NE of Hwy. 25			
22	40	1 mi.	1503	1.0	
	41	2 mi. (from Hwy. 25)	1505	1.15	
21	42	3 mi.	1510	1.35	
20	43	4 mi.	1515	1.3	
		On Sand Spring Road, NE of Hwy. 25			
32	40	1 mi.	1300	10	
		2 mi.	1532	0.3	

Table 5. Dose rates measured off site during surveillance of the Platte event. (cont'd.)

AZIMUTH (°)	DISTANCE (miles)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	$\beta + \gamma$
		On Sand Spring Road, NE of Hwy. 25 (Cont.)			
26	48	11.4 mi.	1545	0.3	
25	51	13.8 mi. (from Hwy. 25)	1550	0.4	
24	54	16.8 mi.	1600	0.6	
	55	17.8 mi.	1602	0.5	
25	56	19.1 mi.	1605	0.4	
		19.2 mi.	1610	0.4	
		At Reed			
4	39		1148	Zero	
			1258	2.0	
			1300	3.0	
			1612	0.03	
		In the vicinity of Reed			
3	38	1 mi.	1307	0.2	
		" (W of Reed)	1320	Zero	
2		2 mi.	1311	Zero	
4	41	2.4 mi. (N of Reed)	1600	0.5	
6	39	1.3 mi.	1338	0.4	
8		2.8 mi. (E of Reed)	1342	2.6	
9		4.2 mi.	1249	21	
10		5.2 mi.	1348	2.6	
		"	1210	0.01	
		"	1213	0.08	
		"	1216	1.0	
		"	1218	4.0	
		"	1220	6.5	
		"	1221	5.0	
		"	1224	4.5	
		"	1225	6.0	
		"	1228	5.0	
		"	1230	6.0	
		"	1232	8.0	
		"	1235	10	
		"	1238	14	
		"	1240	16	
		"	1243	20	
		"	1245	24	
14	41	7.4 mi.	1358	2.2	
15		8.1 mi.	1400	2.2	
		On Nyala Road, going E from its Jct. with Hwy. 25			
3	66	0 mi.	1432	0.8	
7	67	5 mi. (from Jct.)	1435	1.0	
9	69	8 mi.	1440	1.5	
11		10 mi.	1445	2.0	
12	70	12 mi.	1450	2.4	
13	71	13 mi.	1456	2.7	
		13.5 mi.	1458	2.3	

Table 5. Dose rates measured off site during surveillance of the Platte event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr) γ	β + γ
		On Nyala Road, going E from its Jct. with Hwy. 25 (Cont.)			
13	72	14 mi.	1505	1.8	
14	73	16 mi.	1510	1.3	
15		17 mi.	1512	1.6	10
16	74	18 mi.	1515	1.8	12
17	76	21 mi.	1520	2.3	12
		At Nyala			
17	77		1525	2.4	7
			1535	1.9	5
			1538	1.7	4
		On the road to Adaven, going E from its Jct. with the Nyala Road			
18	79	0 mi.	1543	1.9	5
20	80	3 mi.	1550	2.4	
21	79	5 mi.	1600	1.4	3
22	78	7 mi.	1610	1.4	3
		10 mi.	1625	1.4	3
		At Cherry Creek Summit			
22	78		1635	1.4	3
		At Forest Camp			
23	72		1655	1.3	3
		At Beleu's Ranch			
25	71		1705	1.1	
		At Adaven			
26	71		1725	1.1	3
		NE of Adaven			
27	73	2 mi.	1735	0.9	
29	94	24 mi.	1800	0.25	
		At Moon River Ranch			
33	99		1820	0.05	
		At Sunnyside			
35	106		1835	Zero	
		At Lund			
27	130		1930	Zero	
		On Route 6, going NE from Warm Springs			
16	103	57 mi.	1710	Zero	
17	104	57.4 mi. (from Warm	1628	0.4	
	105	59.6 mi. Springs)	1705	0.5	
18	106	59.8 mi.	1713	0.2	
		"	1720	Zero	

Table 5. Dose rates measured off site during surveillance of the Platte event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	$\beta + \gamma$
		On Route 6, going NE from Warm Springs (Cont.)			
18	107	61 mi. (from Warm Springs)	1638	0.2	
19	108	62.1 mi.	1702	0.3	
	110	64 mi.	1725	0.3	
		64.4 mi.	1700	0.2	
	111	65.1 mi.	1648	Zero	
19	112	At Currant	1650	Zero	
			1738	0.2	
			1741	Zero	
		On Route 6, going NE from Currant			
20	117	5.8 mi. (from Currant)	1803	0.2	
22	120	10.1 mi.	1810	0.3	
23	131	22.2 mi.	1820	0.2	
	144	28.1 mi.	1825	0.1	
	145	29.1 mi.	1826	Zero	
25	155	At Ely	1848	Zero	
			4/15/62		
		On Valley Road, N of the Gunnery Range Boundary			
33	31	0 mi.	1139	0.03	0.08
		" At ground level	1139		0.09
35	32	1 mi.	1143	0.04	0.09
		" At ground level	1143		0.10
36	33	2 mi.	1145	0.04	0.09
		" At ground level	1145		0.09
37		3 mi.	1149	0.03	0.07
		" At ground level	1149		0.08
38		4 mi.	1153	0.04	0.05
		" At ground level	1153		0.05
39	35	5.4 mi.	1200	0.03	0.07
		" At ground level	1200		0.07
40	36	At Stewart's Ranch	1204	0.03	0.07
		At ground level	1204		0.07
38	36	1 mile N of Stewart's Ranch	1206	0.02	0.05
		At ground level	1206		0.07
36	36	At Gunderson's Ranch in Penoyer Valley	1212	0.03	0.07
		At ground level	1212	0.03	0.08
3	35	2 miles S of Reed, on the road to Kawich Lake	1314	0.07	

Table 5. Dose rates measured off site during surveillance of the Platte event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PST	DOSE RATE (net mr/hr)	
				γ	β + γ
4	37	At Reed	1330	0.07	
		Going E from Reed to Hwy. 25			
5	38	1 mi.	1335	0.07	
7		2 mi. (from Reed)	1340	0.07	
		3.6 mi.	1341	1.0	
8		4.6 mi.	1342	1.0	
9	39	5.6 mi.	1345	0.9	
11		6.6 mi.	1348	0.8	
14	40	At the Jct. of Hwy. 25 & the road to Reed	1350	0.8	
21	41	At Queen City Summit	1600	0.34	0.06
		At ground level	1600		1.0
8	44	On Hwy. 25, going S from Diablo 6.3 mi.	1535	0.34	0.07
		" At ground level	1535		1.2
7	50	At Diablo	1525	0.04	0.15
355	65	At Hot Creek Pond	1500	Zero	
352	69	At Warm Springs	1400	Zero	
16	104	9 miles SW of Currant	1300	0.03	0.15
22	120	10 miles NE of Currant	1230	0.03	0.15
25	155	At Ely	1140	Zero	0.15
25- 19	155- 115	On Route 6, going from Ely to Currant	1140- 1230	All Zero	

Table 6. Dose rates measured off site during surveillance of the Eel event.

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr)	
				γ	$\beta + \gamma$
			5/19/62		
		On Valley Road, N of the Gunnery Range Boundary			
14	33	.6 mi.	1252	Zero	
		At Stewart's Ranch			
17	34		0940	Zero	
			1300	Zero	
		At Gunderson's Ranch in Penoyer Valley			
15	37		0900	Zero	
		At Tempiute			
24	37	(4 readings)	0915-	All	
			0940	Zero	
			1320	Zero	
		On Hwy. 25, SE of Queen City Summit			
22	38	15.2 mi. (from Queen City	1545	0.02	
		14.9 mi. Summit)	1005	Zero	
26-	39-	14 mi. SE to	0945-	All	
55	43	Hancock Summit	1030	Zero	
19	39	13.3 mi.	0855	Zero	
18		12.5 mi.	0945	Zero	
17		11.5 mi.	0950	Zero	
16		10.5 mi.	0951	Zero	
14	40	9.5 mi.	0952	0.01	
13		8.5 mi.	0953	0.03	
55-	43-	Hancock Summit to 7.8 mi. SE	1035-	All	
13	40	of Queen City Summit	1100	Zero	
13	40	7.8 mi.	1100	0.01	
12	41	7.5 mi.	0954	0.05	
		7.2 mi.	0901	Zero	
11		6.5 mi.	1005	0.05	
10		5.8 mi.	1103	0.1	
9		5.5 mi.	1010	0.35	
		"	1015	0.1	
20-	39-	14-	1326-	All	
9	41	5 mi.	1338	Zero	
8	42	4.5 mi.	1014	1.7	
		4.2 mi.	1016	2.0	
7		4 mi.	1339	0.2	
		3.8 mi.	1106	1.0	
		3.5 mi.	1017	2.4	
		3.3 mi.	1018	3.0	
6		3 mi.	1340	0.4	
		"	1532	0.3	
	43	2.7 mi.	1019	4.0	
		2.5 mi.	1020	4.0	
5		2 mi.	1341	0.6	
		"	1530	0.6	
		1.8 mi.	1110	2.0	
4	44	1 mi.	1343	0.6	

Table 6. Dose rates measured off site during surveillance of the Eel event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr)	
				γ	β + γ
		At Queen City Summit			
3	44		1113	1.7	
			1345	0.4	
			1525	0.7	
			1605	0.4	
		On Hwy. 25, from 1.5 miles SE to 1.5 miles NW of Queen City Summit			
5- 1	43- 44		1023- 1029	All 4.1	
		On Hwy. 25, NW of Queen City Summit			
2	44	1 mi.	1351	0.4	
1	45	2 mi. (from Queen	1353	0.5	
		2.4 mi. City Summit)	1118	2.0	
		2.5 mi.	1035	4.2	
	46	3 mi.	1355	0.5	
		3.5 mi.	1037	4.0	
	47	4 mi.	1357	0.5	
0		4.4 mi.	1120	1.7	
		4.5 mi.	1038	3.8	
		4.8 mi.	1039	3.6	
		4.9 mi.	0937	5.0	
		"	0938	8.0	
		5 mi.	1030	3.0	
		"	1359	0.4	
	48	5.5 mi.	1040	2.6	
		5.9 mi.	0941	10	
	49	6 mi.	1400	0.3	
		6.5 mi.	1043	2.5	
	50	7 mi.	1124	1.0	
		"	1402	0.4	
		7.5 mi.	1044	2.1	
	51	8 mi.	1404	0.3	
		8.5 mi.	1045	1.3	
	52	9 mi.	1046	0.7	
		"	1405	0.15	
359		9.5 mi.	1050	0.1	
		"	1127	0.4	
	53	10 mi.	1407	0.05	
		10.5 mi.	1053	0.05	
		10.8 mi.	1515	0.08	
		On Hwy. 25, from 11 miles NW of Queen City Summit to 28.6 miles NW of Diablo (30 readings)			
359- 350	53- 76		1409- 1501	All Zero	
		At Diablo			
359	55		0925	Zero	
			0947	0.4	
			0952	0.3	
			1035	1.5	
			1055	0.05	

Table 6. Dose rates measured off site during surveillance of the Eel event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr) γ	β + γ
		At Diablo (Cont.)			
359	55		1130	0.05	
			1545	Zero	
		On Hwy. 25, N of Diablo			
359	55	1 mi.	1056	0.03	
	56	1.6 mi. (from Diablo)	0956	0.01	
359- 353	56- 74	2- 24 mi.	1057- 1126	All Zero	
359	58	3.9 mi.	1000	0.05	
	62	7.4 mi.	1138	0.02	
358	63	7.7 mi.	1500	0.01	
		At the Jct. of Hwy. 25 and Nyala Road			
357	70		1019	0.01	
			1450	0.01	
		19.3 miles N of Diablo on Hwy. 25			
356	71		1148	Zero	
		At Warm Springs			
346	75		1205	Zero	
			1230	Zero	
			1454- 2150	All Zero	
		W of Nyala on the Nyala Road			
0	70	19.3 mi.	1448	0.05	
1		18.4 mi. (from Nyala)	1034- 1038	All Zero	
		"	1040	0.01	
		"	1044	0.06	
		"	1046	0.05	
		18.3 mi.	1447	0.08	
		17.5 mi.	1055	0.15	
		17.3 mi.	1446	0.18	
2	71	16.3 mi.	1050	0.25	
		"	1445	0.23	
3		15.3 mi.	1052	0.5	
		14.9 mi.	1100	2.0	
4	72	14.3 mi.	1054	0.85	
		"	1440	0.28	
5		13.3 mi.	1057	1.05	
		12.3 mi.	1100	3.0	
	73	12 mi.	1110	3.0	
6		11.3 mi.	1105	2.5	
7		10.3 mi.	1112	1.15	
		10 mi.	1115	2.2	
8	74	8.3 mi.	1115	0.95	
		8 mi.	1117	1.6	
	75	7.3 mi.	1427	0.42	
9		6.3 mi.	1425	0.28	
		6.1 mi.	1123	0.45	
		6 mi.	1125	0.75	

Table 6. Dose rates measured off site during surveillance of the Eel event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr)	
				γ	β + γ
		W of Nyala on the Nyala Road (Cont.)			
10	76	5.3 mi.	1421	0.18	
11		4 mi. (from Nyala)	1126	0.15	
		"	1130	0.10	
	77	3.3 mi.	1417	0.05	
		2.3 mi.	1415	0.01	
		2 mi.	1131	0.10	
		"	1135	0.06	
		At Nyala			
12	78		1136	0.04	
			1140	0.06	
			1412	Zero	
		N of Nyala on the Nyala Road			
13	79	1.5 mi.	1145	0.08	
14	83	5.8 mi. (from Nyala)	1145	Zero	
16	98	21.3 mi.	1206	0.02	
		21.5 mi. (Troy Mine Road Jct.)	1215	0.08	
	103	25.9 mi. (Blue Eagle Ranch)	1212	0.02	
	104	26.6 mi. (Blue Eagle Ranch)	1214	0.05	
		At Casey's Ranch			
17	80		1400	Zero	
		At Adaven			
21	72		1335	Zero	
		From the Jct. of Hwys. 25 & 38 to Sunnyside			
57-32	51-106		1040-1245	All Zero	
		On Hwy. 6, going NE toward Lockes			
5	95	7.4 mi.	1420	Zero	
6		6.5 mi. (from Lockes)	1306	0.06	
		5.5 mi.	1307	0.06	
		5.2 mi.	1300	0.03	
7	96	3.9 mi.	1305	0.07	
		3.5 mi.	1310	0.11	
		3 mi.	2100	0.01	
	97	2.5 mi	1312	0.14	
8	98	.6 mi.	1410	0.05	
		At Lockes			
8	98		1315	0.14	
		On Hwy. 6, going NE toward Currant			
8	98	21.9 mi.	1311	0.13	
		" (from Currant)	1320	0.24	
	99	21.3 mi.	1321	0.12	
		21 mi.	2056	0.02	
9		20.9 mi.	1321	0.24	
	100	19.9 mi.	1322	0.25	
		19.2 mi.	1325	0.15	

Table 6. Dose rates measured off site during surveillance of the Eel event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr) γ	β + γ
		On Hwy. 6, going NE toward Currant (Cont.)			
10	101	18.1 mi.	1348	0.08	
		17.9 mi. (from Currant)	1324	0.27	
	102	17.1 mi.	1348	0.08	
	103	16.1 mi.	1328	0.07	
		"	1330	0.15	
		"	1345	0.04*	
		"	1345	0.24*	
11		15.1 mi.	1326	0.07	
		15 mi.	2050	0.05	
	104	14.1 mi.	1324	0.08	
12		13.1 mi.	1322	0.08	
	105	12.1 mi.	1320	0.08	
13		11.1 mi.	1318	0.07	
	106	10.1 mi.	1316	0.07	
	107	9.1 mi.	1314	0.07	
		8.1 mi.	1312	0.06	
14	108	7.2 mi.	1355	0.03	
		7.1 mi.	1310	0.07	
	109	6.1 mi.	1308	0.06	
	110	5.1 mi.	1306	0.06	
	111	4.3 mi.	1400	0.01	
		4.1 mi.	1302	0.06	
15	112	3.1 mi.	1300	0.07	
	113	2.1 mi.	1257	0.08	
		At Currant			
15	115		1230	0.08	
			1235	0.10	
			1335	0.04	
			1405	Zero	
			1430	Zero	
			2030	0.02	
		On Hwy. 20, NW of Currant			
14	116	2.8 mi.	1407	0.02	
		3 mi. (from Currant)	1340	0.11	
13	117	5.1 mi.	1410	0.04	
	118	6 mi.	1345	0.12	
12	120	9.5 mi.	1413	0.04	
11		10.3 mi.	1415	0.02	
	121	11 mi.	1350	0.08	
10	122	14.5 mi.	1355	Zero	
		At Duckwater			
9	123		1405	Zero	
		On Hwy. 6, NE of Currant			
16	118	3.9 mi. (from Currant)	1330	0.04	
18	122	9.8 mi. (Currant Maint. Station)	1250	0.05	
		" (Currant Maint. Station)	1315	0.04	
19		11 mi.	1245	0.05	
		12 mi.	1936	0.09	

*These two readings taken with different instruments by different monitors.

Table 6. Dose rates measured off site during surveillance of the Eel event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr) γ	β + γ
		On Hwy. 6, NE of Currant (Cont.)			
20	127	16 mi.	1931	0.06	
21		17 mi. (from Currant)	1240	0.03	
		"	1930	0.02	
	130	20 mi.	1300	0.02	
		"	1345	Zero	
		At the Jct. of Hwys. 6 & 38			
21	138		1230	Zero	
		At Ely			
22	155		1400	Zero	
			1546	Zero	
			1900	Zero	
		On Hwy. 50, W of Ely			
18	160	13 mi.	1535	Zero	
17	161	19 mi. (from Ely)	1430	0.02	
15	158	23 mi.	1433	0.05	
	156	26 mi.	1435	0.07	
14	155	28 mi.	1520	0.08	
13	156	32 mi.	1441	0.08	
		33 mi.	1515	0.07	
11		42 mi.	1450	0.08	
8		47 mi.	1455	0.01	
		49 mi.	1500	Zero	
			5/20/62		
		At the Jct. of Valley Road & Kawich Road			
14	33		082[illegible]	Zero	
			094[illegible]	Zero	
		On Kawich Road W of the Jct. of Valley Road & Kawich Road			
11	35	1.9 mi. (from Jct.)	0946	0.08	
10		2.3 mi.	0947	0.18	
		At Stewart's Ranch			
17	34		0830	Zero	
		On Hwy. 25, SE of Queen City Summit			
18	39	12 mi.	0833	Zero	
		" (from Queen	1010	Zero	
13	40	8.1 mi. City Summit)	0837	Zero	
9	41	5.5 mi.	0840	0.01	
7	42	3.6 mi.	0841	0.05	
6		3 mi.	1020	0.08	
5	43	2 mi.	0843	0.10	
4		1.3 mi.	0844	0.05	
		At Queen City Summit			
3	44		0845	0.08	0.25
			1025	0.11	

Table 6. Dose rates measured off site during surveillance of the Eel event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr)	
				γ	$\beta + \gamma$
		On Hwy. 25, NW of Queen City Summit			
1	45	2.4 mi.	0847	0.06	
	46	3 mi. (from Queen	1030	0.08	
	47	4.1 mi. City Summit)	0849	0.06	
0	49	6.5 mi.	0851	0.05	
359	52	9.6 mi.	0853	0.01	
359	55	At Diablo	0857	Zero	
			1040	0.01	
357	70	At the Jct. of Hwy. 25 & Nyala Road	1130	Zero	
357	70	At Twin Springs Ranch Pond	0915	Zero	
346	75	At Warm Springs	0830	Zero	
			0930	Zero	
			1115	Zero	
		On Hwy. 6, SW of Currant			
8	99	21 mi.	0930	0.01	
12	105	12 mi. (from Currant)	0940	0.03	
14	108	7 mi.	0950	0.03	
15	115	At Currant	1000	0.02	
			----	0.01	
18	122	Currant Maintenance Station, 9.8 miles NE of Currant	----	Zero	
21	138	At the Jct. of Hwys. 6 & 38	----	Zero	
25	131	At Lund	----	Zero	
		W of Nyala on the Nyala Road			
7	73	10.5 mi.	1145	0.02	
8	75	7.2 mi. (from Nyala)	1150	0.06	
10	76	5.5 mi.	1200	0.04	
12	77	1.3 mi.	1205	Zero	
12	78	At Nyala	1210	Zero	
13	81	3 miles NE of Nyala on the Nyala Road	1215	Zero	

Table 7. Dose rates measured off site during surveillance of the Des Moines event.

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME	DOSE RATE (net mr/hr)	
			PDT	γ	$\mu + \gamma$
		At the Jct. of Kawich Road & Valley Road	6/13/62		
32	26		1420	Zero	
		At Reed			
6	36		1500	Zero	
			1510	Zero	
		E of Reed			
7	37	.8 mi.	1528	0.1	
9		2.7 mi. (from Reed)	1534	10	
12		4.5 mi.	1537	75	
14	38	6.2 mi.	1542	130	
16		7 mi.	1544	145	
20	39	8.4 mi.	1547	110	
		At Queen City Summit			
20	39		1500	Zero	
			1510	Zero	
			1515	1.0	
			1516	1.5	
			1517	1.3	
			1520	4	
			1523	11	
			1525	90	
			1526	135	
			1527	160	
			1530	140	
			1535	105	
			1540	100	
			1545	80	
			1546	16	
			1552	17	
			1555	18	
			1600	14	
			1605	10	
			1610	8	
			1615	7	
			1620	6.5	
			1625	7.5	
			1630	6.5	
		At ground level	1632		18
			1640	6.0	
			1645	5.7	
			1700	5.0	
			1705	4.5	
			1720	5.0	
			1730	4.5	
		At ground level	1735	4.5	
			1745	4.0	
			1757	4.5	17
			1800	4.0	
			1825	2.5	
			1845	2.5	
		At ground level	1915	5.0	15

Table 7. Dose rates measured off site during surveillance of the Des Moines event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr)	
				γ	β + γ
		At Queen City Summit (Cont.)			
20	39		1930	4.5	14
		(on vegetation)	1930	8.0	45
			2000	8.0	45
			2000	2.5	7.0
			2100	2.0	4.0
		On Hwy. 25, NW of Queen City Summit			
19	39	.3 mi.	1531	90	
16	40	2.4 mi. (from Queen	1530	75	
14		3.6 mi. City Summit)	1529	55	
13	41	4 mi.	1810	25	
		4.3 mi.	1528	15	
12		5.2 mi.	1527	12	
13		6 mi.	1820	35	
		At Diablo			
8	50	Readings taken at ground level	1537	0.15	
			1538	0.3	
			1539	1.5	
			1540	2.0	
			1541	9.8	
			1542	19	
			1543	24	
			1544	38	
			1545	42	
			1546	12	
			1547	4.0	
			1548	3.8	
			1549	4.0	
			1550	4.5	
			1552	14	
			1553	18	
			1554	11	
			1555	8	
			1556	12	
			1557	44	
			1558	26	
			1559	14	
		Readings taken 3 feet above ground level	1500	Zero	
			1600	20	40
			1601	15	29
			1602	7.5	17.3
			1604	9.0	35.0
			1606	7.5	17.0
			1614	6.8	15.0
			1616	5.5	15.0
			1619	5.0	13.5
			1620	5.5	12.0
			1622	5.4	12.0
			1625	3.6	9.0
			1628	4.0	9.5
			1630	3.8	9.5

Table 7. Dose rates measured off site during surveillance of the Des Moines event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr) γ	DOSE RATE (net mr/hr) β + γ
8	50	At Diablo (Cont.)	1632	4.0	10.5
			1634	4.3	9.5
			1637	4.0	9.4
			1640	3.0	7.6
			1643	3.4	7.0
			1646	3.4	7.0
			1649	3.1	6.1
			1652	3.1	6.5
			1655	3.0	7.0
			1658	3.0	5.0
			1701	3.0	5.4
			1704	2.9	3.0
			1707	2.9	5.5
			1710	2.5	5.5
			1713	2.9	5.5
			1716	2.6	5.5
			1722	2.5	5.0
			1725	2.5	4.5
			1728	2.5	4.5
			1731	2.5	4.2
			1734	2.3	4.0
			1739	2.2	4.0
			1743	2.0	4.0
			1746	2.0	3.5
			1749	2.1	
			1758	2.0	3.3
			1801	1.5	3.5
			1804	2.0	3.5
			1807	2.0	3.5
			1810	1.9	3.0
		At ground level	1820	2.0	
			1824	1.8	3.0
			1830	1.8	3.0
			1840	1.5	3.0
			1850	1.5	3.3
			1900	1.5	2.9
			1905	1.5	3.0
0	67	At Twin Springs Ranch	1540	Zero	
			1630	Zero	
			1700	Zero	
			1715	Zero	
352	67	At Warm Springs	1530	Zero	
			1730	Zero	
			1840	Zero	
			2008	Zero	
4	64	At the Jct. of Hwy. 25 & the Nyala Road	1615	Zero	
			1938	0.2	

Table 7. Dose rates measured off site during surveillance of the Des Moines event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr) γ	DOSE RATE (net mr/hr) β + γ
		W of Nyala on the Nyala Road			
6	64	20.6 mi.	1648	Zero	
		20.5 mi. (from Nyala)	1616	Zero	
	65	20 mi.	1932	0.5	
		19.8 mi.	1702	0.08	
		19.5 mi.	1650	0.07	
7		18.5 mi.	1652	0.4	
8		17.9 mi.	1928	0.9	
	66	17.3 mi.	1656	0.7	
		16.9 mi.	1925	0.9	
9		15.1 mi.	1700	0.7	
10	67	14.8 mi.	1702	4.0	
		14.7 mi.	1922	2.5	
		14.5 mi.	1705	5.0	
12		12.8 mi.	1710	6.5	
	68	12.6 mi.	1918	3.0	
		11.7 mi.	1715	16.5	
13	69	10.7 mi.	1720	15.5	
		10.5 mi.	1914	6.0	
14		9.9 mi.	1732	16.5	
	70	8.9 mi.	1725	14.5	
		8.4 mi.	1909	7.0	
15	71	7.1 mi.	1730	18	
		" At ground level	1730	25	
16		6.4 mi.	1630	20	
		6.3 mi.	1904	7.0	
17	72	5 mi.	1737	15.5	
		4.4 mi.	1750	12.5	
18	73	2.8 mi.	1754	8.5	
19	74	1.7 mi.	1756	7.0	
		At Nyala			
19	75		1640	20	
			1643	30	
			1646	40	
			1647	50	
			1648	70	
			1649	80	
			1650	100	
			1651	80	
			1652	75	
			1700	65	
			1703	60	
			1801	8.0	
			1808	8.0	
			1820	7.5	
			1849	5.0	
		N of Nyala			
20	76	.6 mi.	1822	4.5	
	77	1.5 mi. (from Nyala)	1825	4.0	
	79	3.1 mi.	1829	3.2	
	81	5.4 mi.	1835	3.0	

Table 7. Dose rates measured off site during surveillance of the Des Moines event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr) γ	β + γ
		N of Nyala (Cont.)			
21	88	12.9 mi.	1745	4.0	
	97	22.7 mi. (from Nyala)	1740	24	
		"	1800	7.5	
	100	25.5 mi.	1803	6.0	
		"	1805	6.0	
		At Currant			
20	112		1820	11.0	
			1840	3.0	
			2032	2.5	4.0
		At ground level	2032	5	15
		On Hwy. 6, SW of Currant			
7	86	35.5 mi.	1917	Zero	
8	87	33.4 mi. (from Currant)	1919	0.01	
9	88	31.4 mi.	1921	0.06	
	89	30.4 mi.	1923	0.09	
10	90	28.3 mi.	1933	0.3	
11	91	26.3 mi.	1940	0.5	
12	93	24.2 mi.	1945	1.0	
13	94	22.2 mi.	1950	1.0	
15	97	18.1 mi.	1955	2.0	
	98	18 mi.	1700	Zero	
		17.1 mi.	2000	3.0	
	99	16.1 mi.	2005	3.0	
16	101	14 mi.	2008	3.0	
17		13 mi.	1720	0.05	
		"	1724	0.5	
		"	1725	0.8	
		"	1726	2.0	
		"	1727	5.0	
		"	1728	10	
		"	1729	17	
		"	1731	19	
		"	1735	30	
		"	1736	40	65
		"	1739	70	
		"	1741	100	
		"	1743	100	
		"	1745	100	
		"	1747	90	
		"	1749	80	
		"	1750	80	
		"	1752	80	
		"	1753	70	
		"	1753	60	
		"	1755	45	
		"	1800	30	
	102	12 mi.	2012	3.5	
18	103	10 mi.	2015	4.1	
19	107	5.9 mi.	2020	3.2	
	109	3.9 mi.	2025	2.5	
20	111	1.8 mi.	2027	2.5	

Table 7. Dose rates measured off site during surveillance of the Des Moines event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr)	
				γ	β + γ
		On Hwy. 6, NE of Currant			
20	114	1.2 mi. (from Currant)	2036	2.5	7.0
		" At ground level	2036	4.5	14
21	115	3.2 mi.	2039	2.0	4.0
		" At ground level	2039	3	10
	117	5.3 mi.	2045	2.0	4.5
		" At ground level	2045	4	14
22	119	7.3 mi.	2056	2.5	5.2
		" At ground level	2056	4	10
23	121	11.4 mi.	2105	1.0	1.4
		" At ground level	2105	1.1	3.5
24	126	16.5 mi.	2115	0.1	0.15
		" At ground level	2115	0.4	0.8
25	135	26.7 mi.	2122	0.1	0.2
		" At ground level	2122	0.3	0.5
	143	36.9 mi.	2135	0.06	0.1
		" At ground level	2135	0.06	0.1
	148	42 mi.	2140	0.03	
	149	43.2 mi.	2155	0.01	
26	156	At Ely	2210	Zero	
13	119	At Duckwater	1849	3.5	
		On Hwy. 20, NW of Duckwater			
11	122	7.4 mi.	1856	0.7	
9	130	17 mi. (from Duckwater)	1909	0.07	
6	137	26.6 mi.	1921	0.09	
4	143	36.2 mi.	1932	0.05	
5	150	At the Jct. of Hwys. 50 & 20, 8 miles S of Eureka	1936	0.05	
3	159	At Eureka	2018	0.03	
			6/14/62		
33	32	At the Jct. of Kawich and Valley Roads	1031	Zero	
38	36	At Stewart's Ranch	1038	Zero	
20	39	At Queen City Summit	1127	0.6	
22	41	At Queen City Pond	1136	0.3	0.6
		At ground level	1136	0.4	1.5

Table 7. Dose rates measured off site during surveillance of the Des Moines event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr) γ	β + γ
		On Hwy. 25, SE of Queen City Summit			
24	39	3.2 mi.	1155	0.04	
32	38	8.5 mi. (from Queen	1204	0.04	
36		11.3 mi. City Summit)	1209	0.02	
42	39	16 mi.	1215	Zero	
		S of Queen City Pond			
23	40	1 mi.	1156	0.21	0.31
		" At ground level	1156	0.2	0.5
24		2 mi.	1202	0.02	0.21
		" At ground level	1202	0.04	0.11
26	39	3 mi.	1210	Zero	.02
		" At ground level	1210	Zero	0.1
27	39	At the Jct. of Hwy. 25 and the road to Queen City Pond	1215	Zero	Zero
43	39	At Tempiute	1230	Zero	
		At Diablo			
8	50		1127	0.23	
			1610	0.1	0.1
		At ground level	1610	0.4	0.5
8	55	10 miles S of the Jct. of Hwy. 25 and the Nyala Road	1555	Zero	
4	64	At the Jct. of Hwy. 25 and the Nyala Road	1520	Zero	
352	67	At Warm Springs	1500	Zero	
0	67	At Twin Springs Ranch	1530	Zero	
		W of Nyala			
14	69	10.2 mi. (from Nyala)	1500	1.2	1.8
		" At ground level	1500	1.4	4.5
9	67	15.3 mi.	1508	0.3	0.3
		" At ground level	1508	0.3	0.4
8	66	17.3 mi.	1514	0.06	0.15
		" At ground level	1514	0.08	0.15
		S of Nyala			
19	71	4.5 mi.	1432	1.0	1.5
		" At ground level	1432	1.0	3.5
		" On vegetation	1432	1.3	3.5
30	72	At Adaven (Simpson's Ranch)	1515	0.02	

Table 7. Dose rates measured off site during surveillance of the Des Moines event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr)	
				γ	β + γ
29	71	At Uhalde Ranch	1530	0.01	
28	65	At Pine Creek Ranch	1554	Zero	
30- 32	72- 38	On Sand Springs Road from Adaven to Hwy. 25	---- ----	All Zero	
20	78	At Cherry Creek Turn-off	1400	0.31	
		E of Cherry Creek Turn-off			
23	77	6.5 mi.	1415	0.17	
25	74	12.2 mi.	1430	0.07	
19	75	At Nyala	1410	0.9	1.5
		At ground level	1410	1.0	1.9
		On vegetation	1410	1.4	4.0
		S of Currant			
21	100	14.5 mi. (from Currant)	1220	0.4	0.8
		" At ground level	1220	0.7	1.6
		" On vegetation	1220	1.0	2.7
	97	17.1 mi.	1237	0.4	0.6
		" At ground level	1237	0.6	1.2
		17.3 mi.	1320	0.3	0.5
		" At ground level	1320	0.7	1.0
		" On vegetation	1320	0.5	1.1
	87	27.5 mi.	1345	0.3	0.4
		" At ground level	1345	0.4	0.9
20	77	37.5 mi.	1405	0.6	0.9
		" At ground level	1405	0.8	1.8
		On Hwy. 6, SW of Currant			
20	107	5.1 mi. (from Currant)	1142	0.6	1.2
		" At ground level	1142	1.0	3.5
18	103	10 mi.	----	0.7	
21		10.2 mi.	1157	0.6	1.1
		" At ground level	1157	0.7	1.8
17	102	12 mi.	----	0.8	
	101	13 mi.	----	1.0	
16	100	15 mi.	----	0.4	
15	99	16 mi.	----	0.7	
20	112	At Currant	1100	0.8	
			1127	0.8	1.5
		At ground level	1127	1.7	3.2
			1817	1.0	

Table 7. Dose rates measured off site during surveillance of the Des Moines event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr)	
				γ	$\beta + \gamma$
		At Lockes			
14	95		1210	0.25	
			1300	.20	
		8 miles SW of Lockes			
10	90		1320	Zero	
		At the Jct. of Hwys. 20 & 50			
5	150		1550	Zero	
		S of the Jct. of Hwys. 20 & 50			
4	142	8.6 mi.	1600	0.01	
7	135	15.3 mi. (from Jct.)	1615	Zero	
8	134	16.9 mi.	1635	Zero	
9	132	20.3 mi.	1645	Zero	
10	128	25.3 mi.	1655	Zero	
11	124	30.8 mi.	1700	0.03	
	122	32.8 mi.	1706	0.11	
12		35.3 mi.	1710	0.13	
	121	37.8 mi.	1713	0.13	
13	120	40.3 mi.	1718	0.5	
		41.1 mi. (Duckwater School)	1720	0.5	
		At Duckwater			
13	119		1722	0.5	
		S of Duckwater			
13	118	1.3 mi.	1725	0.7	
14		2.3 mi. (from Duckwater)	1728	0.9	
15	116	2.3 mi. S, 2.2 mi. W (Ranch)	1740	0.8	
14	118	2.3 mi.	1755	0.9	
15		4.3 mi.	175′	1.2	
	117	5.9 mi.	1801	1.2	
16	116	7.9 mi.	1804	1.3	
17	115	9.9 mi.	1807	1.6	
18	114	11.9 mi.	1810	1.5	
19	113	13.9 mi.	1813	1.0	
		At Ely			
26	156		0900	0.12	
			0950	Zero	
		On Hwy. 50, W of Ely			
24	158	5.7 mi.	0928	0.13	
19	162	20.1 mi. (from Ely)	0943	1.1	
		19.5 mi.	0947	0.8	
		19 mi.	0949	0.7	
20	163	18.6 mi.	0951	0.6	
		18.1 mi.	0953	0.5	
		17.4 mi.	0956	0.5	
		17.1 mi.	0958	0.5	
		16.6 mi.	0959	0.5	
		16.1 mi.	1001	0.5	
21		15.6 mi.	1003	0.4	

Table 7. Dose rates measured off site during surveillance of the Des Moines event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr) γ	β + γ
		On Hwy. 50, W of Ely (Cont.)			
21	163	15.1 mi.	1005	0.5	
	162	14.6 mi. (from Ely)	1007	0.4	
		14.1 mi.	1009	0.3	
		13.6 mi.	1010	0.25	
	161	13.1 mi.	1012	0.20	
22		12.6 mi.	1014	0.17	
		12.1 mi.	1015	0.15	
		11.6 mi.	1017	0.15	
19	162	20.1 mi.	1028	1.1	
		20.6 mi.	1031	1.0	
	161	21.1 mi.	1033	1.1	
		21.6 mi.	1035	0.9	
18		22.1 mi.	1035	1.0	
		" On vegetation	1035	2.3	
	160	22.6 mi.	1048	1.2	
	159	23.1 mi.	1050	1.2	
		23.6 mi.	1052	1.2	
	158	24.1 mi.	1053	1.1	
		24.6 mi.	1054	1.1	
	157	25.1 mi.	1055	1.0	
		25.6 mi.	1057	1.0	
17	156	26.1 mi.	1059	1.0	
		" On vegetation	1059	2.0	
		26.6 mi.	1100	1.1	
	155	27.1 mi.	1103	1.3	
		27.6 mi.	1105	1.2	
		28.1 mi.	1107	1.2	
		28.6 mi.	1109	1.4	
		" On vegetation	1109	2.0	
	154	29.1 mi.	1115	1.3	
		29.6 mi.	1117	1.4	
16		30.1 mi.	1119	1.5	
		" On vegetation	1119	2.5	
		30.6 mi.	1121	1.5	
	153	31.1 mi.	1123	1.5	
		31.6 mi.	1125	1.4	
	154	32.1 mi.	1127	1.4	
		32.6 mi.	1129	1.2	
15		33.1 mi.	1132	0.9	
		At Moorman Ranch (off Hwy. 50)	1135	0.9	
		" " On vegetation	1135	1.6	
		33.1 mi. (on Hwy. 50 again)	1140	0.9	
		33.6 mi.	1148	1.0	
		34.1 mi.	1152	1.1	
		34.6 mi.	1154	1.1	
	155	35.1 mi.	1156	1.2	
		35.6 mi.	1158	1.3	
14		36.1 mi.	1200	1.2	
		37.1 mi.	1202	1.0	
		38.1 mi.	1204	1.1	
		39.1 mi.	1206	0.5	
		39.6 mi.	1207	0.4	

Table 7. Dose rates measured off site during surveillance of the Des Moines event. (cont'd.)

AZIMUTH (°)	DISTANCE (mile)	LOCATION	CLOCK TIME PDT	DOSE RATE (net mr/hr)	
				γ	β + γ
		On Hwy 50, W of Ely (Cont.)			
13	154	40.1 mi. (from Ely)	1208	0.4	
		Illipah Maint. Station	1209	0.4	
		" " " On vegetation	1209	0.6	
		41.1 mi.	1216	0.21	
		41.6 mi.	1218	0.16	
		42.1 mi.	1219	0.21	
		42.6 mi.	1220	0.21	
12		43.1 mi. (Antelope Summit)	1223	0.31	
		43.6 mi.	1226	0.21	
	155	44.1 mi.	1228	0.13	
		44.6 mi.	1230	0.06	
		45.1 mi.	1231	0.04	
11		46.1 mi.	1233	0.03	
10	154	51.1 mi.	1245	0.01	
9	152	55.3 mi.	1250	0.02	
6	150	58.5 mi.	1300	0.03	
		" On vegetation	1300	0.13	
		At Eureka			
3	159		1325	Zero	
			1500	Zero	

APPENDIX B

DOSIMETRY DATA FROM FILM BADGES EXPOSED OFF SITE DURING OPERATION NOUGAT

Table No.		Page
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Table 2.	Gamma exposure to film badges placed at reference stations during Operation Nougat.	B-10
Table 3.	Gamma exposure to film badges placed at stations located off site during Operation Nougat.	B-16

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Figure 2.	Dose measured by film badges exposed at off-site stations during Operation Nougat.	B-12

Table 1. Gamma exposure to film badges worn by off-site residents during Operation Nougat.

LOCATION Azimuth and Distance from CP-1	PERSON	EXPOSURE PERIOD	DOSE (mr)
Adaven 17°, 86 miles	100	5/24 - 6/20	< 30
	101	5/24 - 6/20	< 30
	102	5/24 - 6/20	< 30
Alamo 57°, 57 miles	103	2/07 - 3/27 3/27 - 5/03 5/03 - 6/04	lost < 30 lost
	104	2/04 - 3/23 3/23 - 5/10 5/10 - 6/04	< 30 < 30 lost
Ash Springs 53°, 59 miles	105	2/07 - 3/15 3/15 - 6/04	65 < 30
Baker 35°, 178 miles	106	2/07 - 8/30	< 30
	107	2/07 - 8/30	< 30
Beatty 268°, 38 miles	108	2/05 - 7/31	< 30
	109	2/05 - 7/31	< 30
	110	2/01 - 3/09	< 30
	111	2/05 - 7/31	< 30
	112	2/05 - 6/29	< 30
	113	2/05 - 7/31	< 30
Beatty (cont'd)	114	2/12 - 7/31	< 30
	115	2/12 - 7/31	< 30
	116	1/25 - 2/26 2/26 - 5/28	30 < 30
	117	2/05 - 7/31	< 30
	118	2/05 - 7/31	< 30
	119	5/28 - 7/31	< 30
	120	2/05 - 3/09 3/09 - 6/29	55 < 30
	121	2/05 - 7/31	< 30
	122	2/05 - 7/31	< 30
	123	2/12 - 7/31	< 30
	124	5/28 - 7/31	< 30
	125	1/25 - 3/07 3/07 - 7/31	30 < 30
	126	2/05 - 7/31	< 30
	127	2/05 - 6/01	< 30
	128	2/05 - 7/31	< 30

Table 1. Gamma exposure to film badges worn by off-site residents during Operation Nougat. (continued)

LOCATION Azimuth and Distance from CP-1	PERSON	EXPOSURE PERIOD	DOSE (mr)
Beatty (cont'd)	129	3/16 - 7/31	< 30
	130	2/05 - 7/31	< 30
	131	2/05 - 7/23	< 30
	132	1/25 - 4/04	< 30
	133	2/05 - 7/31	< 30
	134	5/28 - 7/31	< 30
Blue Eagle Ranch 13°, 105 miles	135	6/12 - 6/19	50
		6/19 - 7/04	< 30
	136	6/12 - 6/19	55
		6/19 - 7/04	< 30
	137	5/09 - 6/11	< 30
		6/11 - 6/19	75
	138	6/19 - 7/04	< 30
	139	6/11 - 6/19	90
		6/19 - 7/04	< 30
	140	5/09 - 6/19	55
		6/19 - 7/04	< 30
	141	5/16 - 6/19	100
		6/19 - 7/04	< 30
	142	5/09 - 6/19	65
		6/19 - 7/04	< 30
Caliente 59°, 97 miles	143	2/13 - 3/15	50
		3/15 - 4/26	40
		4/26 - 7/28	lost
	144	2/01 - 3/08	50
		3/08 - 4/26	< 30
	145	2/13 - 3/15	50
		3/15 - 4/20	< 30
		4/26 - 6/04	< 30
	146	2/21 - 3/22	< 30
		3/22 - 5/02	< 30
		5/02 - 6/05	< 30
	147	2/21 - 6/05	< 30
	148	3/22 - 5/06	70
		5/06 - 6/04	< 30
	149	3/22 - 6/04	< 30
	150	2/01 - 3/15	90
		3/15 - 6/12	< 30
		6/12 - 6/26	55
	151	1/31 - 3/14	55
		3/14 - 6/11	< 30
	152	2/13 - 3/14	50
		3/14 - 6/05	< 30

Table 1. Gamma exposure to film badges worn by off-site residents during Operation Nougat. (continued)

LOCATION Azimuth and Distance from CP-1	PERSON	EXPOSURE PERIOD	DOSE (mr)
Caliente (cont'd)	153	2/01 - 6/04	<30
Carp 81°, 88 miles	154	2/01 - 3/27	lost
		3/27 - 4/26	<30
	155	3/27 -	lost
Carver's Rest 335°, 143 miles	156	2/21 - 9/07	<30
Casey Ranch 13°, 95 miles	157	5/16 - 6/20	80
	158	5/16 - 6/20	150
	159	5/16 - 6/20	75
Clark's Station 341°, 90 miles	160	3/06 - 9/07	<30
	161	3/06 - 9/07	<30
Currant Maint. Station 16°, 135 miles	162	2/06 - 6/11	<30
		6/11 - 6/19	75
		6/19 - 7/03	<30
	163	2/06 - 3/07	<30
		3/07 - 4/17	35
		4/17 - 6/11	<30
		6/11 - 6/19	55
		6/19 - 7/03	<30
Diablo Maint. Station 0°, 69 miles	164	5/15 - 6/19	<30
	165	3/07 - 4/17	<30
		4/17 - 5/15	<30
		5/15 - 6/19	50
Death Valley Junction 202°, 46 miles	166	2/01 - 3/23	<30
Duckwater 8°, 137 miles	167	5/09 - 6/12	<30
		6/12 - 7/02	90
	168	5/16 - 6/20	<30
		6/20 - 7/04	70
	169	5/09 - 7/03	<30
	170	6/12 - 7/04	50
Elgin 70°, 89 miles	171	2/01 - 3/30	heat damage
		3/30 - 4/26	lost
Ely 21°, 172 miles	172	5/09 - 7/03	<30
	173	2/06 - 7/02	<30
	174	2/06 - 9/04	<30
	175	2/07 - 7/02	<30
	176	2/22 - 9/05	<30

Table 1. Gamma exposure to film badges worn by off-site residents during Operation Nougat. (continued)

LOCATION Azimuth and Distance from CP-1	PERSON	EXPOSURE PERIOD	DOSE (mr)
Ely (cont'd)	177	2/07 - 7/02	<30
	178	2/06 - 7/02	<30
	179	2/06 - 9/05	<30
	180	3/10 - 9/07	<30
	181	2/06 - 7/02	<30
	182	2/13 - 9/05	<30
	183	2/06 - 7/03	<30
	184	2/07 - 7/02	<30
	185	2/06 - 9/06	<30
	186	2/06 - 9/04	<30
	187	2/06 - 7/02	<30
	188	2/06 - 7/02	<30
	189	2/07 - 7/02	<30
	190	2/06 - 7/02	<30
	191	2/06 - 9/04	<30
	192	2/06 - 9/04	<30
Ely (cont'd)	193	2/06 - 9/07	<30
	194	2/06 - 9/06	<30
Enterprise 69°, 137 miles	195	2/21 - 8/08	<30
	196	2/06 - 9/06	<30
	197	1/31 - 9/05	<30
	198	2/21 - 7/31	<30
Eureka 1°, 183 miles	199	2/07 - 8/31	<30
	200	2/14 - 6/12	<30
Furnace Creek 233°, 54 miles	201	2/01 - 4/17	<30
	202	2/01 - 8/01	<30
	203	5/21 - 8/01	<30
	204	2/01 - 6/29	<30
	205	2/01 - 4/17	<30
	206	6/29 - 7/31	<30
	207	2/01 - 8/01	<30
	208	2/01 - 8/01	<30

Table 1. Gamma exposure to film badges worn by off-site residents during Operation Nougat. (continued)

LOCATION Azimuth and Distance from CP-1	PERSON	EXPOSURE PERIOD	DOSE (mr)
Gardner Ranch 18°, 147 miles	209	2/14 - 6/12	<30
		6/12 - 7/02	45
	210	4/17 - 6/12	<30
		6/12 - 7/03	40
	211	2/14 - 7/03	<30
Goldfield 311°, 111 miles	212	1/24 - 9/07	<30
	213	1/24 - 9/07	<30
Geyser Maint. Station 33°, 140 miles	214	2/07 - 8/30	<30
	215	2/13 - 8/30	<30
	216	2/21 - 8/30	<30
Elko 44°, 64 miles	217	2/12 - 9/03	<30
	218	2/20 - 6/18	<30
		6/18 - 7/01	285
	219	2/07 - 3/15	65
		3/15 - 6/04	<30
	220	2/20 - 7/01	<30
Hot Creek Ranch 353°, 111 miles	221	2/13 - 3/07	<30
		3/07 - 4/17	<30
		4/17 - 6/19	damaged
Lathrop Wells 223°, 26 miles	222	3/12 - 7/30	<30
	223	2/06 - 3/16	<30
Lathrop Wells (cont'd)	224	1/29 - 3/14	< 30
	225	1/29 - 3/09	60
		3/09 - 4/25	50
		4/25 - 5/29	< 30
	226	2/06 - 7/03	< 30
	227	1/29 - 3/14	< 30
	228	4/25 - 7/03	< 30
	229	2/06 - 7/30	< 30
	230	1/26 - 7/31	< 30
	231	1/29 - 8/01	< 30
	232	1/29 - 8/01	< 30
	233	1/29 - 8/01	< 30
	234	1/31 - 3/14	< 30
	235	1/25 - 7/30	< 30
	236	2/08 - 5/29	< 30
	237	4/25 - 5/29	< 30
	238	4/25 - 8/01	< 30

Table 1. Gamma exposure to film badges worn by off-site residents during Operation Nougat. (continued)

LOCATION Azimuth and Distance from CP-1	PERSON	EXPOSURE PERIOD	DOSE (mr)
Las Vegas 136°, 72 miles	239	3/09 - 5/08	< 30
	240	2/10 - 3/11	< 30
Lida 299°, 91 miles	241	3/01 - 9/07	< 30
Lida Junction 304°, 73 miles	242	1/25 - 9/07	< 30
Littlefield 90°, 118 miles	243	1/31 - 9/05	< 30
	244	1/31 - 9/05	< 30
Lockes 8°, 114 miles	245	2/06 - 6/11	< 30
		6/11 - 6/19	65
		6/19 - 7/04	< 30
Lund 22°, 145 miles	246	2/14 - 7/02	< 30
	247	2/21 - 7/02	< 30
	248	3/15 - 6/19	< 30
	249	2/21 - 6/19	< 30
Manzonie Ranch 15°, 130 miles	250	2/13 - 6/12	< 30
		6/12 - 6/19	75
		6/19 - 7/03	< 30
	251	2/13 - 6/12	< 30
		6/12 - 6/19	90
Manzonie Ranch (cont'd)	252	6/19 - 7/03	30
	253	2/13 - 6/12	< 30
		6/12 - 6/19	75
		6/19 - 7/03	35
	254	6/19 - 7/03	< 30
	255	5/16 - 6/12	< 30
		6/12 - 6/19	110
		6/19 - 7/03	30
Mesquite 94°, 110 miles	256	1/31 - 3/14	< 30
		3/14 - 4/24	< 30
	257	1/31 - 7/31	< 30
Modena 61°, 132 miles	258	1/31 - 7/31	< 30
Nyala 11°, 94 miles	259	5/16 - 6/19	125
	260	5/16 - 6/19	250
	261	5/16 - 6/19	220
Pahrump 176°, 50 miles	262	3/20 - 7/30	< 30
	263	5/17 - 6/21	< 30
	264	1/29 - 7/30	< 30
	265	2/21 - 7/30	< 30

Table 1. Gamma exposure to film badges worn by off-site residents during Operation Nougat. (continued)

LOCATION Azimuth and Distance from CP-1	PERSON	EXPOSURE PERIOD	DOSE (mr)
Pahrump (cont'd)	266	2/20 - 4/25	<30
	267	2/21 - 7/03	<30
	268	2/22 - 7/30	<30
	269	2/22 - 7/30	<30
	270	2/22 - 4/25	<30
Panaca 56°, 108 miles	271	1/31 - 3/14	50
		3/14 - 6/05	<30
	272	1/31 - 3/14	<30
	273	3/22 - 6/05	<30
Gunderson's Ranch 18°, 49 miles	274	6/06 - 7/19	<30
	275	3/05 - 6/08	<30
Pine Creek Ranch 17°, 77 miles	276	5/24 - 6/20	<30
	277	5/24 - 6/20	<30
Pioche 50°, 112 miles	278	2/07 - 3/15	50
		3/15 - 6/05	<30
	279	3/22 - 6/05	<30
	280	2/07 - 3/15	55
		3/15 - 4/25	damaged
Pioche (cont'd)	281	4/25 - 6/12	lost
	282	3/22 - 4/25	<30
		4/25 - 6/05	lost
	283	2/13 - 3/15	60
		3/15 - 6/05	<30
	284	2/07 - 4/25	<30
	285	2/13 - 3/15	50
		3/15 - 6/05	<30
Rattlesnake Maint. Stn. 358°, 107 miles	286	2/07 - 3/22	<30
		3/22 - 4/25	<30
		4/25 - 5/15	<30
		5/15 - 6/19	<30
Rhyolite 268°, 24 miles	287	1/25 - 7/31	<30
	288	1/25 - 7/31	<30
Santa Clara 83°, 133 miles	289	2/20 - 9/06	<30
	290	1/31 - 9/06	<30
Sarcobatus 296°, 57 miles	291	2/12 - 9/07	<30
	292	2/12 - 9/07	<30
Scotty's Junction 297°, 60 miles	293	1/25 - 9/07	<30
Shelburne 20°, 214 miles	294	2/07 - 8/31	<30
	295	2/07 - 8/31	<30
Shell Oil Site 13°, 117 miles	296	5/16 - 9/12	<30

Table 1. Gamma exposure to film badges worn by off-site residents during Operation Nougat. (continued)

LOCATION Azimuth and Distance from CP-1	PERSON	EXPOSURE PERIOD	DOSE (mr)
Springdale 261°, 38 miles	297	1/25 - 7/31	<30
St. George 84°, 137 miles	298	2/20 - 9/06	<30
	299	2/06 - 9/06	<30
	300	2/07 - 9/05	<30
	301	4/11 - 9/06	<30
	302	2/20 - 9/06	<30
	303	1/31 - 7/31	<30
	304	2/20 - 9/06	<30
	305	2/20 - 9/06	<30
	306	2/20 - 9/06	<30
	307	2/03 - 9/06	<30
	308	2/21 - 8/09	<30
Stone Cabin Ranch 342°, 94 miles	309	6/13 - 6/21	<30
	310	6/13 - 6/21	<30
	311	6/13 - 6/21	<30
	312	6/13 - 6/21	<30
Stone Cabin Ranch(cont)	313	6/13 - 6/21	<30
Stovepipe Wells 250°, 62 miles	314	2/01 - 3/21	<30
Sunnyside 27°, 119 miles	315	2/21 - 7/02	<30
Tonopah 322°, 101 miles	316	1/25 - 9/07	<30
	317	6/12 - 6/21	<30
	318	2/06 - 9/07	<30
	319	5/31 - 9/07	<30
	320	6/12 - 6/21	<30
	321	6/12 - 6/21	<30
	322	2/06 - 4/06	<30
	323	2/06 - 9/07	<30
	324	2/06 - 3/16	<30
Tonopah Highway Sta. 322°, 101 miles	325	1/25 - 3/16 3/16 - 5/16 5/16 - 9/07	<30 35 <30
Veyo 75°, 133 miles	326	1/31 - 9/06	<30

Table 1. Gamma exposure to film badges worn by off-site residents during Operation Nougat. (continued)

LOCATION Azimuth and Distance from CP-1	PERSON	EXPOSURE PERIOD	DOSE (mr)
Twin Springs Ranch 357°, 88 miles	327	5/15 - 6/19	<30
	328	2/13 - 5/15	<30
		5/15 - 6/19	40
	329	5/15 - 6/19	damaged
Warm Springs 350°, 89 miles	330	1/26 - 3/16	<30
		3/16 - 4/25	<30
		4/25 - 5/15	<30
		5/15 - 6/19	<30
Warm Springs Ranch 101°, 75 miles	331	2/07 - 3/15	80
		3/15 - 6/04	<30

Table 2. Gamma exposure to film badges placed at reference stations during Operation Nougat.

LOCATION Azimuth and Distance from CP-1	EXPOSURE PERIOD	DOSE (mr)
Blue Eagle Ranch 13°, 105 miles	6/11 - 6/19	90
Blue Eagle Ranch #2 13°, 105 miles	5/16 - 6/11 6/11 - 6/19	<30 125
Currant Creek 14°, 128 miles	5/09 - 6/11 6/11 - 6/19	<30 100
Currant Maint. Sta. 16°, 135 miles	5/09 - 6/11 6/11 - 6/19	<30 100
Duckwater 8°, 137 miles	6/12 - 6/19	55
Gardner Ranch 18°, 147 miles	4/17 - 6/12	<30
Hiko 44°, 64 miles	3/21 - 9/03	<30
Hiko #2 44°, 65 miles	4/16 - 7/01	<30
Lockes 8°, 114 miles	4/17 - 6/11 6/11 - 6/19	<30 120
Shell Oil Site 13°, 117 miles	5/16 - 6/12 6/12 - 6/19	<30 150
Sunnyside (Whipple Ranch) 27°, 119 miles	4/18 - 7/02	<30

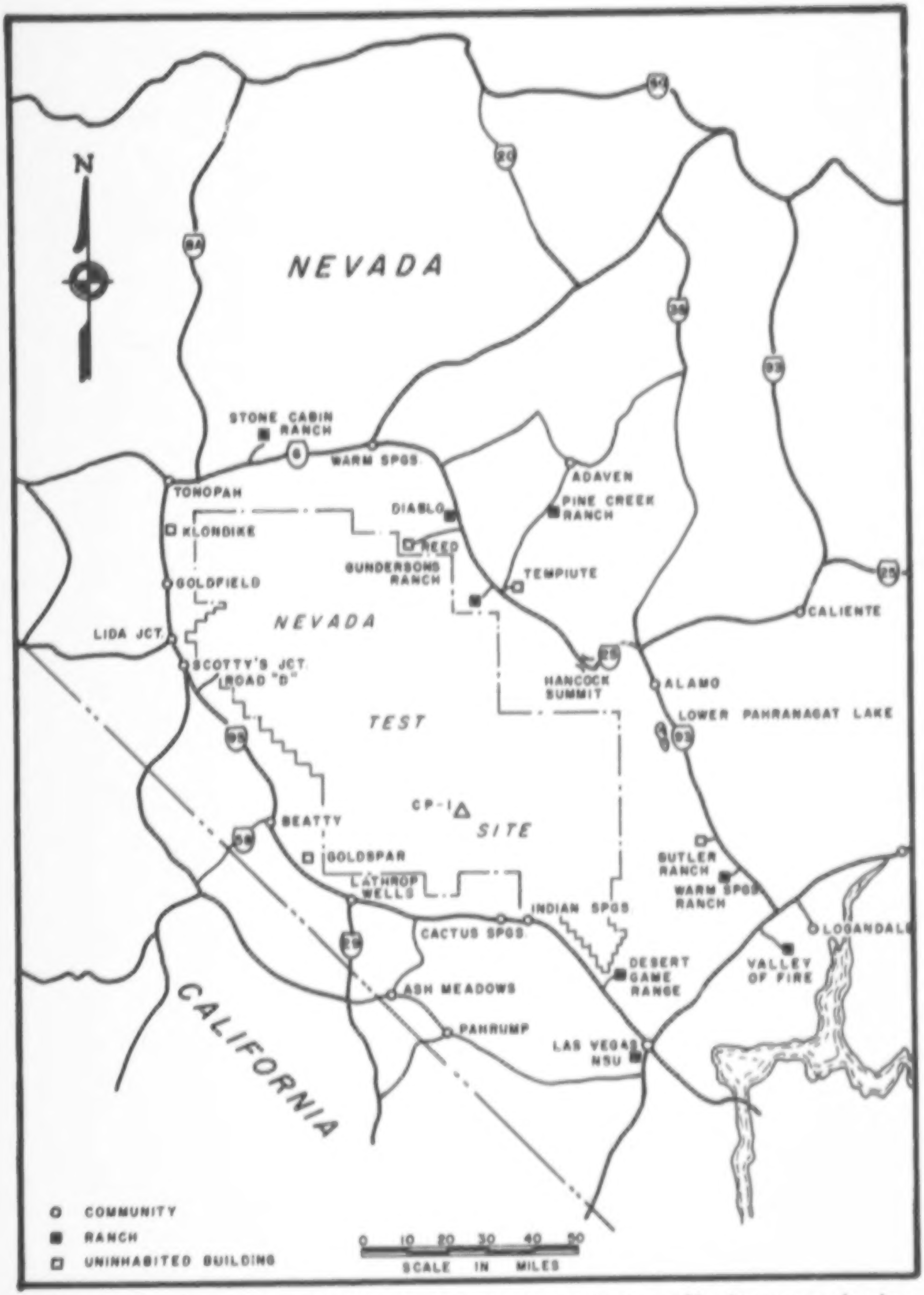
N
NEVADA
20
93
STONE CABIN RANCH
6
WARM SPGS.
TONOPAH
ADAVEN
PINE CREEK RANCH
DIABLO
KLONDIKE
REED
GUNDERSONS RANCH
TEMPIUTE
GOLDFIELD
25
CALIENTE
NEVADA
LIDA JCT.
SCOTTY'S JCT.
ROAD "D"
25
HANCOCK SUMMIT
ALAMO
LOWER PAHRANAGAT LAKE
TEST
95
93
CP-1
SITE
BEATTY
GOLDSPAR
BUTLER RANCH
WARM SPGS RANCH
LATHROP WELLS
INDIAN SPGS
CACTUS SPGS.
LOGANDALE
DESERT GAME RANGE
VALLEY OF FIRE
CALIFORNIA
ASH MEADOWS
PAHRUMP
LAS VEGAS
NSU
COMMUNITY
RANCH
UNINHABITED BUILDING
0 10 20 30 40 50
SCALE IN MILES

Figure 1. Locations of film badge stations in the off-site area during Operation Nougat.

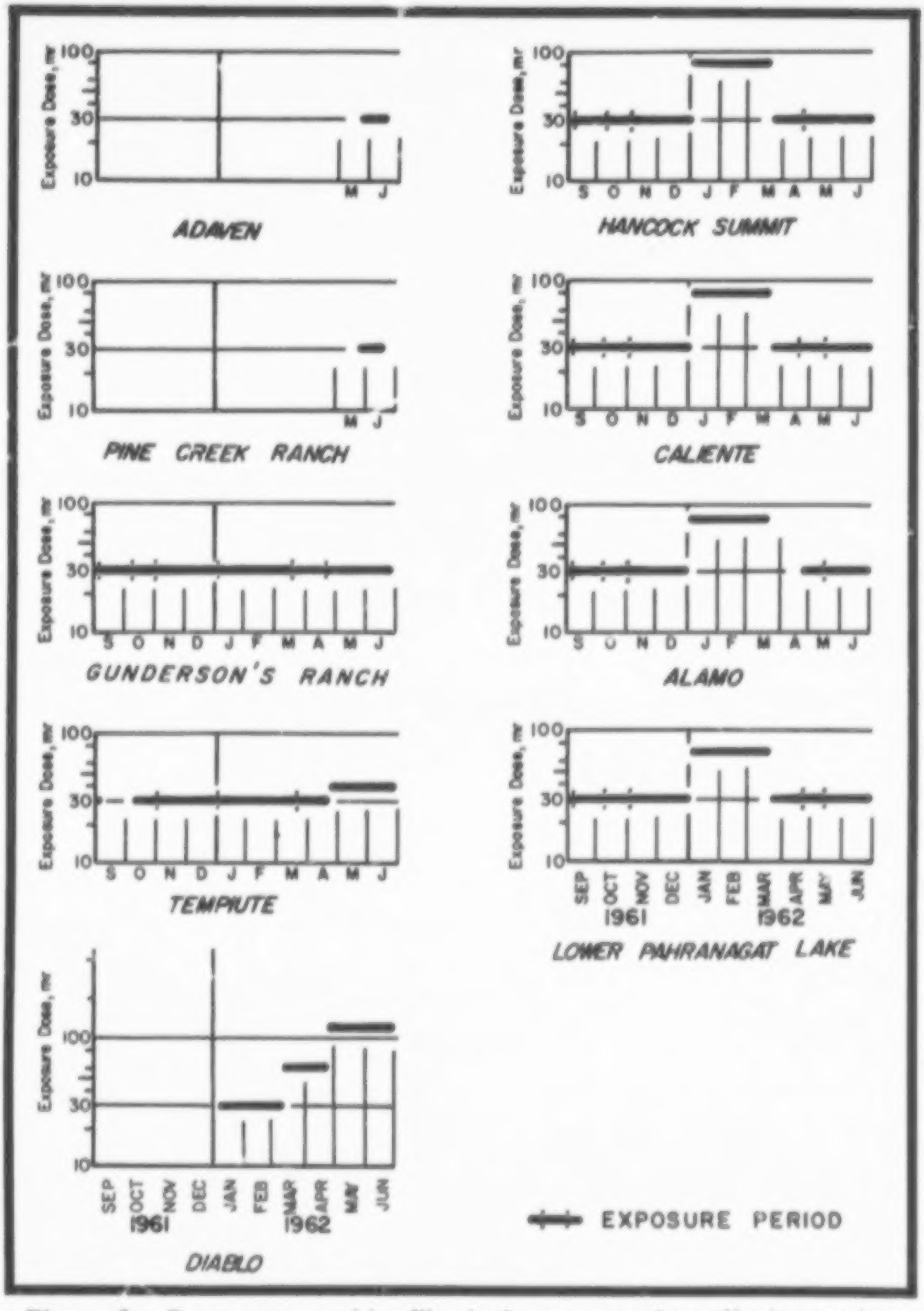

Figure 2. Dose measured by film badges exposed at off-site stations during Operation Nougat.

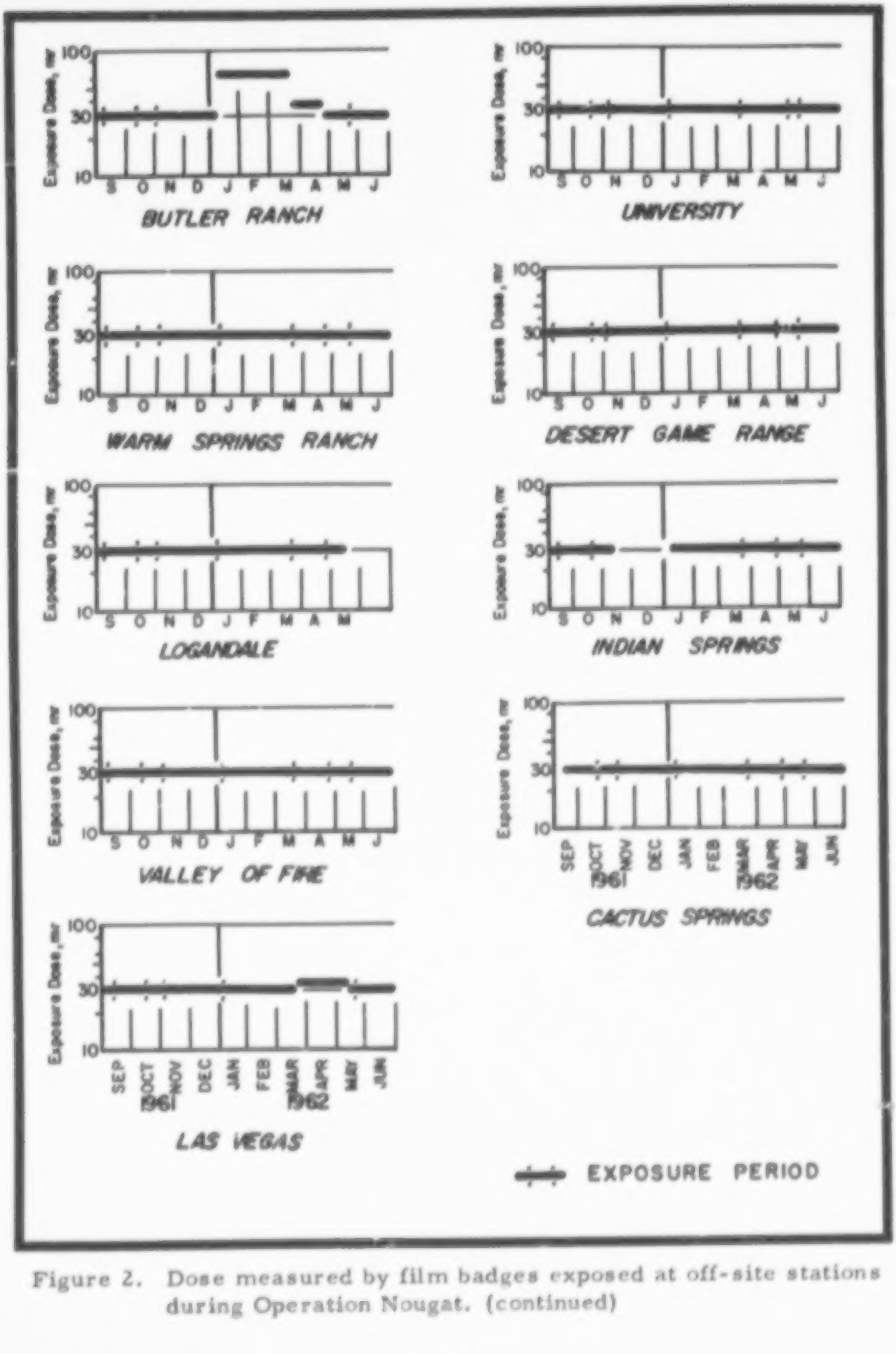

Figure 2. Dose measured by film badges exposed at off-site stations during Operation Nougat. (continued)

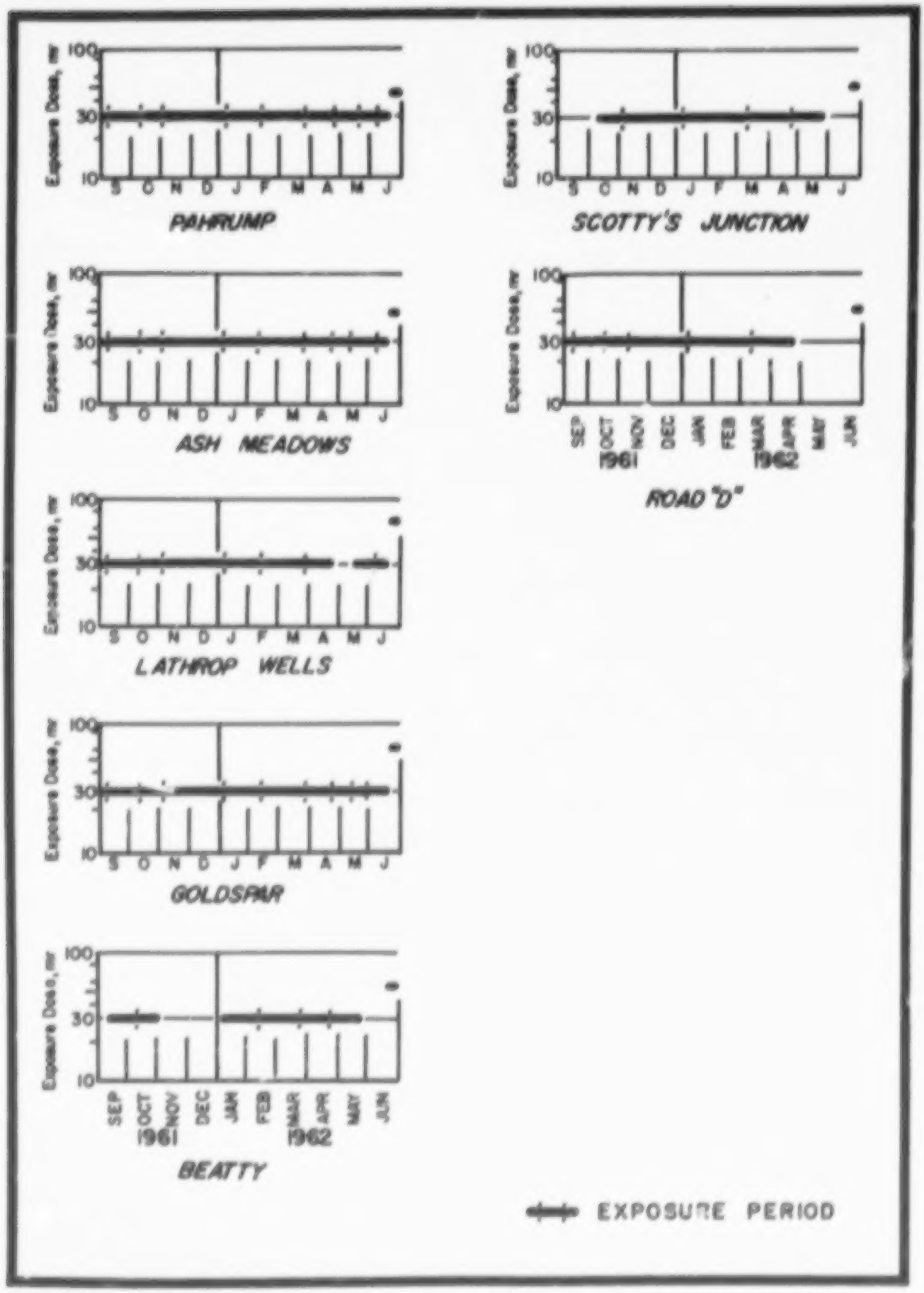

Figure 2. Dose measured by film badges exposed at off-site stations during Operation Nougat. (continued)

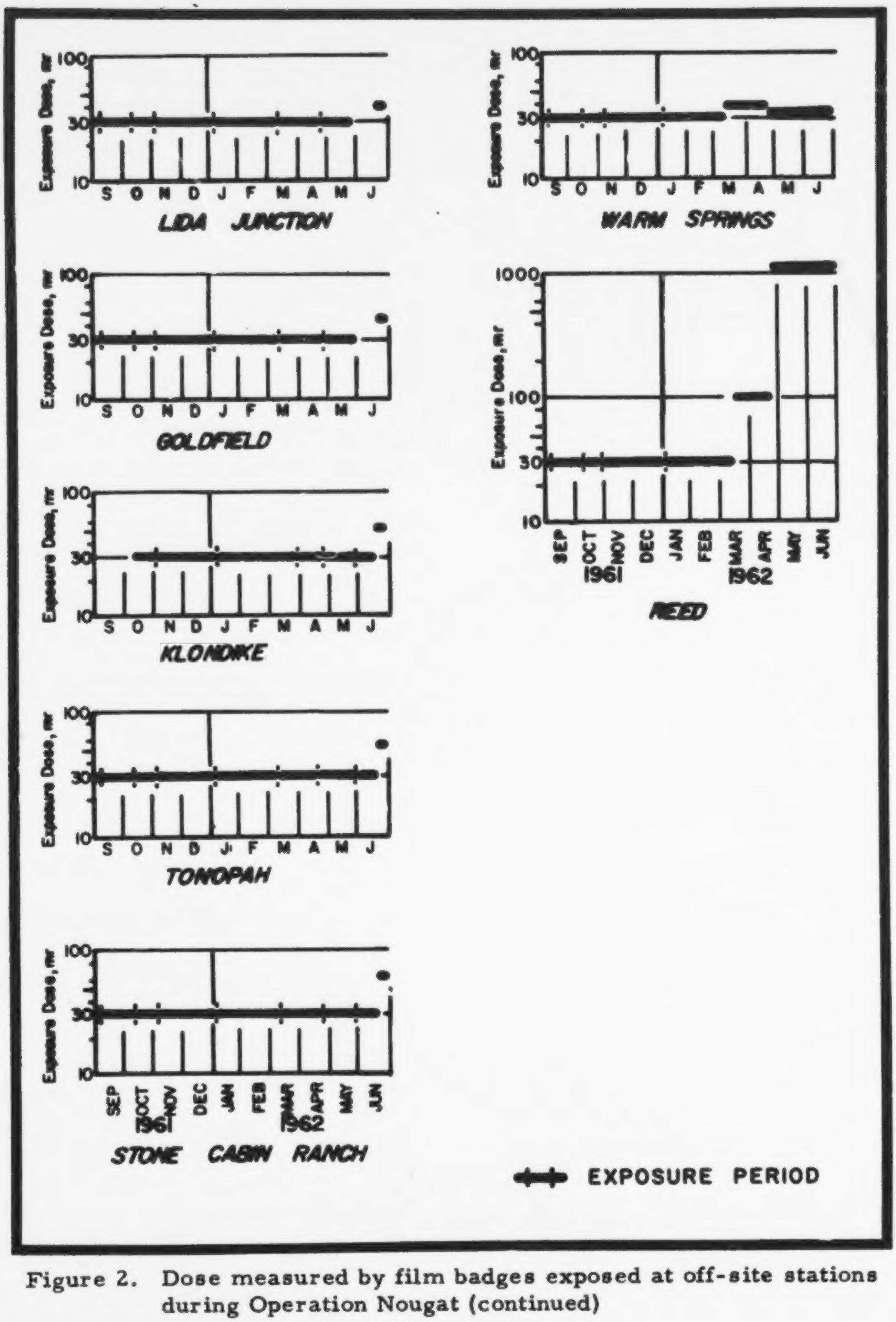

Figure 2. Dose measured by film badges exposed at off-site stations during Operation Nougat (continued)

Table 3. Gamma exposure to film badges placed at stations located off site during Operation Nougat.

LOCATION Azimuth and Distance from CP-1	EXPOSURE PERIOD	DOSE (mr)
Alamo 57°, 57 miles	9/05 - 10/10	< 30
	10/10 - 11/05	< 30
	11/05 - 01/02	< 30
	1/02 - 03/23	76
	3/23 - 04/26	Lost
	4/26 - 05/16	< 30
	5/16 - 07/25	< 30
Ash Meadows 200°, 42 miles	9/06 - 10/12	< 30
	10/12 - 11/03	< 30
	11/03 - 01/04	< 30
	1/04 - 02/12	< 30
	2/12 - 03/27	< 30
	3/27 - 04/25	< 30
	4/25 - 05/11	< 30
	5/11 - 06/05	< 30
	6/05 - 06/22	< 30
Beatty 268°, 38 miles	9/03 - 10/10	< 30
	10/10 - 01/02	Lost
	1/02 - 02/12	< 30
	2/12 - 03/27	< 30
	3/27 - 04/24	< 30
	4/24 - 05/28	< 30
	5/28 - 06/21	L. D.
Butler Ranch 86°, 59 miles	9/03 - 10/12	< 30
	10/12 - 11/03	< 30
	11/03 - 01/02	< 30
	1/02 - 03/23	65
	3/23 - 04/26	38
	4/26 - 05/16	< 30
	5/16 - 07/26	< 30
Cactus Springs 151°, 29 miles	9/04 - 10/25	< 30
	10/25 - 11/05	< 30
	11/05 - 01/02	< 30
	1/02 - 03/21	< 30
	3/21 - 04/27	< 30
	4/27 - 05/17	< 30
	5/17 - 07/02	< 30
Caliente 59°, 97 miles	9/02 - 10/05	< 30
	10/05 - 11/02	< 30
	11/02 - 01/02	< 30
	1/03 - 03/22	79
	3/22 - 04/26	< 30
	4/26 - 05/16	< 30
	5/16 - 07/25	< 30
Desert Game Range 132°, 52 miles	9/04 - 10/22	< 30
	10/22 - 11/04	< 30
	11/04 - 01/02	< 30
	1/02 - 03/22	< 30
	3/22 - 04/27	< 30
Desert Game Range (cont'd)	4/27 - 05/17	< 30
	5/17 - 07/05	< 30
Diablo 0°, 69 miles	1/03 - 03/08	< 30
	3/08 - 04/25	61
	4/25 - 06/29	114
Goldfield 311°, 84 miles	9/04 - 10/11	< 30
	10/11 - 11/02	< 30
	11/02 - 01/02	< 30
	1/02 - 03/08	< 30
	3/08 - 04/24	< 30
	4/24 - 05/28	< 30
	5/28 - 06/21	L. D.
Goldspar 248°, 35 miles	9/02 - 10/10	< 30
	10/10 - 11/03	< 30
	11/03 - 01/02	< 30
	1/02 - 02/12	< 30
	2/12 - 03/27	< 30
	3/27 - 04/26	< 30
	4/26 - 05/11	< 30
	5/11 - 05/28	< 30
	5/28 - 06/19	< 30
Gunderson's Ranch 20°, 48 miles	9/02 - 10/06	< 30
	10/06 - 11/01	< 30
	11/01 - 01/03	< 30
	1/03 - 03/23	< 30
	3/23 - 04/25	< 30
	4/25 - 06/29	22
Hancock Summit 45°, 52 miles	9/02 - 10/08	< 30
	10/08 - 11/02	< 30
	11/02 - 01/03	< 30
	1/03 - 03/23	81
	3/23 - 04/25	< 30
	4/25 - 06/01	< 30
Indian Springs 140°, 33 miles	9/05 - 10/25	< 30
	10/25 - 01/02	< 30
	1/02 - 03/21	< 30
	3/21 - 04/27	< 30
	4/27 - 05/17	< 30
	5/17 - 07/02	< 30
Klondike 317°, 93 miles	10/05 - 11/02	< 30
	11/02 - 01/02	< 30
	1/02 - 03/29	< 30
	3/29 - 04/24	< 30
	4/24 - 05/28	< 30
	5/28 - 06/21	< 30
Las Vegas 136°, 72 miles	9/06 - 10/20	< 30
	10/20 - 11/03	< 30
	11/03 - 01/02	< 30

Table 3. Gamma exposure to film badges placed at stations located off site during Operation Nougat. (continued)

LOCATION Azimuth and Distance from CP-1	EXPOSURE PERIOD	DOSE (mr)
Las Vegas (cont'd)	1/02 - 03/02	<30
	3/21 - 05/10	33
	5/10 - 05/16	<30
	5/16 - 07/05	<30
Lathrop Wells 222°, 27 miles	9/03 - 10/05	<30
	10/05 - 11/02	<30
	11/02 - 01/02	<30
	1/02 - 02/12	<30
	2/12 - 03/27	<30
	3/27 - 04/25	<30
	4/25 - 05/11	N. R.
	5/11 - 06/04	<30
	6/04 - 06/19	<30
Lida Junction 303°, 73 miles	9/03 - 10/10	<30
	10/10 - 11/02	<30
	11/02 - 01/02	<30
	1/02 - 03/08	<30
	3/08 - 04/24	<30
	4/24 - 05/28	<30
	5/28 - 06/21	<30
Lincoln Mine 23°, 51 miles	1/03 - 03/23	<30
	3/23 - 04/25	<30
	4/25 - 06/29	40
Logandale 105°, 90 miles	9/03 - 10/10	<30
	10/10 - 11/01	<30
	11/01 - 01/02	<30
	1/02 - 03/21	<30
	3/21 - 04/24	<30
	4/24 - 05/15	<30
	5/15 - 07/02	L. D.
Lower Pahranagat Lake 68°, 58 miles	9/03 - 10/05	<30
	10/05 - 11/02	<30
	11/02 - 01/02	<30
	1/02 - 03/23	71
	3/23 - 04/26	<30
	4/26 - 05/15	<30
	5/15 - 07/26	<30
Pahrump 176°, 51 miles	9/03 - 10/07	<30
	10/07 - 11/02	<30
	11/02 - 01/04	<30
	1/04 - 02/12	<30
	2/12 - 03/27	<30
	3/27 - 04/25	<30
	4/25 - 05/17	<30
	5/17 - 06/05	<30
	6/05 - 06/22	<30
Pine Creek Ranch 16°, 77 miles	5/24 - 06/20	<30

LOCATION Azimuth and Distance from CP-1	EXPOSURE PERIOD	DOSE (mr)
Reed 357°, 57 miles (Unpopulated)	9/04 - 10/10	<30
	10/10 - 11/01	<30
	11/01 - 01/03	<30
	1/03 - 03/16	<30
	3/16 - 04/25	97
	4/25 - 06/29	1080
Road "D" 292°, 53 miles (Unpopulated)	9/04 - 10/20	<30
	10/20 - 11/10	<30
	11/10 - 01/02	<30
	1/02 - 03/07	<30
	3/07 - 04/24	<30
	4/24 - 05/28	L. D.
	5/28 - 06/21	L. D.
Scotty's Junction 295°, 57 miles	10/04 - 11/02	<30
	11/02 - 01/02	<30
	1/02 - 03/07	<30
	3/07 - 04/24	<30
	4/24 - 05/28	L. D.
	5/28 - 06/21	L. D.
Simpson Ranch (Adaven) 17°, 86 miles	5/24 - 06/20	<30
Stone Cabin Ranch 337°, 91 miles	9/03 - 10/10	<30
	10/10 - 11/03	<30
	11/03 - 01/02	<30
	1/02 - 03/08	<30
	3/08 - 04/25	<30
	4/25 - 05/29	<30
	5/29 - 06/21	<30
Tonopah 321°, 100 miles	9/03 - 10/10	<30
	10/10 - 11/02	<30
	11/02 - 01/02	<30
	1/02 - 03/08	<30
	3/08 - 04/24	<30
	4/24 - 05/31	<30
	5/31 - 06/21	<30
University 139°, 75 miles	9/10 - 10/25	<30
	10/25 - 11/04	<30
	11/04 - 01/02	<30
	1/02 - 03/21	<30
	3/21 - 05/04	<30
	5/04 - 05/16	<30
	5/16 - 07/02	<30
Valley of Fire 112°, 78 miles	9/03 - 10/15	<30
	10/15 - 11/03	<30
	11/03 - 01/02	<30
	1/02 - 03/21	<30
	3/21 - 04/24	<30

Table 3. Gamma exposure to film badges placed at stations located off site during Operation Nougat. (continued)

LOCATION Azimuth and Distance from CP-1	EXPOSURE PERIOD	DOSE (mr)
Valley of Fire (cont'd)	4/24 - 05/15	< 30
	5/15 - 07/02	< 30
Warm Springs 350°, 90 miles	9/02 - 10/15	< 30
	10/15 - 11/05	< 30
	11/05 - 01/02	< 30
	1/02 - 03/08	< 30
	3/08 - 04/25	36
	4/25 - 06/29	33
Warm Springs Ranch 102°, 75 miles	9/03 - 10/10	< 30
	10/10 - 11/02	< 30
	11/02 - 01/02	< 30
	1/02 - 03/23	< 30
	3/23 - 04/26	28
	4/26 - 05/16	< 30
	5/16 - 07/02	< 30

APPENDIX C

AIR SAMPLING DATA OBTAINED FOR OFF-SITE SURVEILLANCE OF SEVEN EVENTS OF OPERATION NOUGAT

Table No.		Page
Table 1.	Concentrations of activity in air sampled by filters and cartridges at off-site locations during the Antler event.	C-1
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Table 4.	Concentrations of activity in air sampled by filters and cartridges at off-site locations during the Danny Boy event.	C-4
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Notes

In the tables of Appendix C, azimuth and distance are given with respect to the Ground Zero for each event.

Time is given as the prevailing clock time at the Nevada Test Site.

Abbreviations used throughout these tables are:

F - 8" x 10" glass fiber filter

C - MSA charcoal cartridge

CORR. TO: - time to which activity counted was corrected for decay by extrapolation

CP - time of peak cloud activity during cloud passage over that location

MP - mid-point of the sampling period

TC - time at which the count was taken

BKG - background

ND - not detected

D - detected, but in amounts too small to quantitate

Table 1 - Concentrations of activity in air sampled by filters and cartridges at off-site locations during the Antler Event.

I. STATION LOCATION			II. COLLECTION DATA							COLLECTOR	III. RADIOASSAY DATA							
STATION NAME	AZIMUTH (°)	DISTANCE (miles)	AIR VOLUME (M3)	SAMPLING PERIOD							GROSS β COUNT		GAMMA PULSE HEIGHT ANALYSIS					
				BEGIN			END				CORR. TO:	ACTIVITY (pc/M³)	CORR. TO:	ACTIVITY (pc/M³)				
				Month	Day	Time	Month	Day	Time					I^{131}	I^{133}	I^{135}	Te^{132}	Ba^{140} La^{140}
Alamo	77	59	1310	9	15	0800	9	15	2025	F	--	BKG	--	ND	ND	ND	ND	ND
										C	--	---	--	D	ND	ND	ND	ND
Diablo	8	51	921	9	15	0700	9	15	1650	F	CP	28	CP	0. 4	2	8	1	ND
										C	--	---	CP	1	32	140	ND	ND
			1154	9	15	1655	9	16	0700	F	--	BKG	--	ND	ND	ND	ND	ND
										C	--	---	MP	1	37	ND	ND	ND
Hiko	62	61	612	9	15	0945	9	15	1930	F	--	BKG	--	ND	ND	ND	ND	ND
										C	--	---	--	D	ND	ND	ND	D
Warm Springs	352	70	5100	9	13	1130	9	15	1605	F	--	BKG	--	ND	ND	ND	ND	D
										C	--	---	--	ND	ND	ND	ND	D
			2400	9	15	1610	9	16	1600	F	--	BKG	--	ND	ND	ND	ND	ND
										C	--	---	MP	0. 3	7. 5	ND	ND	ND
Bald Mountain (unpopulated)	40	25	----	9	15	1700	9	16	1500	F	--	BKG	--	ND	ND	ND	ND	ND
										C	--	---	--	ND	ND	ND	ND	ND

Table 2 - Concentrations of activity in air sampled by filters and cartridges at off-site locations during the Feather Event.

I. STATION LOCATION			II. COLLECTION DATA							COLLECTOR	III. RADIOASSAY DATA										
				SAMPLING PERIOD							GROSS β COUNT		GAMMA PULSE HEIGHT ANALYSIS								
				BEGIN			END							ACTIVITY (pc/M³)							
STATION NAME	AZIMUTH (°)	DISTANCE (miles)	AIR VOLUME (M3)	Month	Day	Time	Month	Day	Time		CORR. TO:	ACTIVITY (pc/M³)	CORR. TO:	$^{131}\mathrm{I}$	$^{133}\mathrm{I}$	$^{135}\mathrm{I}$	$^{135}\mathrm{Xe}$	$^{140}\mathrm{La}$	$^{95}\mathrm{Nb}$	$^{103}\mathrm{Ru}$	$^{141}\mathrm{Ce}$
Ash Meadows	185	57	826	12	22	1642	12	23	0830	F	MP	30	--	--	--	--	--	--	--	--	--
										C	--	---	MP	ND	5.5	2.6	D	ND	ND	ND	ND
Bettle's Farm	200	48	81	12	22	1530	12	22	1705	F	MP	440	MP	ND	21	50	D	D	D	D	D
										C	--	---	MP	ND	270	950	D	ND	ND	ND	ND
			336	12	22	1710	12	22	2400	F	--	BKG	--	--	--	--	--	--	--	--	--
										C	--	---	MP	ND	20	24	D	ND	ND	ND	ND
Death Valley Jct.	189	61	255	12	22	1155	12	22	1700	F	MP	220	--	ND	ND	21	D	D	D	D	D
										C	--	---	MP	ND	40	132	D	ND	ND	ND	ND
			754	12	22	1710	12	23	0815	F	MP	40	--	ND	ND	ND	ND	D	D	D	D
										C	--	---	MP	D	16	1.7	D	ND	ND	ND	ND
Lathrop Wells	196	39	342	12	22	0830	12	22	1517	F	MP	65	MP	ND	ND	5.6	D	D	D	D	D
										C	--	---	MP	ND	13	42	D	ND	ND	ND	ND
			805	12	22	1520	12	23	0740	F	--	BKG	--	ND	ND	ND	ND	D	D	D	D
										C	--	---	MP	0.3	23	24	D	ND	ND	ND	D
Shoshone	181	84	588	12	22	1740	12	23	0750	F	--	23	--	ND	ND	ND	ND	D	D	D	D
										C	--	---	MP	D	12	7.9	D	ND	ND	ND	ND

Table 3 - Concentrations of activity in air sampled by filters and cartridges at off-site locations during the Pampas Event.

I. STATION LOCATION			II. COLLECTION DATA							COLLECTOR	III. RADIOASSAY DATA											
				SAMPLING PERIOD							GROSS β COUNT		GAMMA PULSE HEIGHT ANALYSIS									
				BEGIN			END							ACTIVITY (pc/M³)								
STATION NAME	AZIMUTH (°)	DISTANCE (miles)	AIR VOLUME (M3)	Month	Day	Time	Month	Day	Time		CORR. TO:	ACTIVITY (pc/M³)	CORR. TO:	I^{131}	I^{132}	I^{133}	I^{135}	Te^{132}	Zr^{95} Nb^{95}	Ru^{103}	Ce^{141} Ce^{144}	ThB
Diablo	358	62	200	3	1	1330	3	1	1730	F	MP	830	MP	8.9	D	200	260	36	D	D	D	ND
										C	--	---	MP	ND	D	29	68	ND	ND	ND	ND	ND
			995	3	1	1735	3	2	1305	F	--	BKG	--	--	--	--	--	--	--	--	--	--
										C	--	---	MP	ND	ND	2.1	ND	ND	D	D	D	D
Gunderson's Ranch	19	42	255	3	1	1245	3	1	1750	F	MP	1700	MP	8.6	D	180	240	31	D	D	ND	ND
										C	MP	---	MP	ND	ND	36	106	ND	ND	ND	ND	ND
			853	3	1	1755	3	2	1100	F	--	BKG	--	--	--	--	--	--	--	--	--	--
										C	--	---	MP	ND	ND	2.3	3.1	ND	D	D	D	D
Hiko	48	58	705	3	1	1625	3	2	0900	F	MP	75	--	--	--	--	--	--	--	--	--	--
										C	--	---	MP	ND	ND	2.6	ND	ND	ND	ND	ND	D
Warm Springs	348	82	860	3	1	1430	3	2	1200	F	--	BKG	--	--	--	--	--	--	--	--	--	--
										C	--	---	--	ND	ND	ND	ND	ND	D	D	D	D

Table 4 - Concentrations of activity in air sampled by filters and cartridges at off-site locations during the Danny Boy event.

I. STATION LOCATION			II. COLLECTION DATA							COLLECTOR	III. RADIOASSAY DATA									
STATION NAME	AZIMUTH (°)	DISTANCE (miles)	AIR VOLUME (M3)	SAMPLING PERIOD							GROSS β COUNT		GAMMA PULSE HEIGHT ANALYSIS							
				BEGIN			END							ACTIVITY (pc/M³)						
				Month	Day	Time	Month	Day	Time		CORR. TO:	ACTIVITY (pc/M³)	CORR. TO:	I^{131}	I^{133}	I^{135}	Te^{132}	Ba^{140} La^{140}	Ru^{103}	Sr^{91}
Carver's Restaurant	339	121	472	3	5	1715	3	6	1530	F	--	BKG	--	ND	ND	ND	ND	ND	D	ND
										C	--	---	MP	0.71	61	ND	ND	ND	D	ND
Warm Springs	360	74	167	3	5	1020	3	5	1515	F	MP	1000	MP	6.9	187	275	16	ND	D	D
										C	--	---	MP	ND	33.7	73.5	ND	ND	D	ND

Table 5 - Concentrations of activity in air sampled by filters and cartridges at off-site locations during the Platte event.

I. STATION LOCATION			II. COLLECTION DATA							COLLECTOR	III. RADIOASSAY DATA									
STATION NAME	AZIMUTH (°)	DISTANCE (miles)	AIR VOLUME (M3)	SAMPLING PERIOD							GROSS β COUNT		GAMMA PULSE HEIGHT ANALYSIS							
				BEGIN			END							ACTIVITY (pc/M³)						
				Month	Day	Time	Month	Day	Time		CORR. TO:	ACTIVITY (pc/M³)	CORR. TO:	I^{131}	I^{133}	I^{135}	Te^{132}	Ba^{140} La^{140}	Ru^{103}	Ru^{105}
Currant	19	115	2142	4	14	0800	4	15	0800	F	MP	2300	MP	400	2100	ND	400	4.3	ND	ND
Diablo	7	44	256	4	14	1000	4	14	1650	F	MP	10,000	MP	525	2700	2000	370	12.6	ND	D
										C	--	---	MP	55.3	762	2800	ND	ND	ND	ND
			679	4	14	1700	4	15	0700	F	MP	500	MP	17.3	87	ND	13.3	ND	ND	ND
										C	--	---	MP	18.3	236	165	ND	ND	ND	ND
Ely	25	155	2467	4	14	1100	4	15	0830	F	MP	250	MP	14.2	52	ND	10.9	ND	ND	ND
			414	4	15	0830	4	15	1220	F	MP	54	MP	3.1	D	ND	2.5	ND	D	ND

Table 5 - Concentrations of activity in air sampled by filters and cartridges at off-site locations during the Platte event. (cont'd.)

I. STATION LOCATION			II. COLLECTION DATA							COLLECTOR	III. RADIOASSAY DATA									
STATION NAME	AZIMUTH (°)	DISTANCE (miles)	AIR VOLUME (M3)	SAMPLING PERIOD							GROSS β COUNT		GAMMA PULSE HEIGHT ANALYSIS							
				BEGIN			END							ACTIVITY (pc m3)						
				Month	Day	Time	Month	Day	Time		CORR. TO:	ACTIVITY (pc m3)	CORR. TO:	I^{131}	I^{133}	I^{135}	Te^{132}	Ba^{140} La^{140}	Ru^{103}	Ru^{105}
Gunderson's Ranch	36	34	105	4	14	1100	4	14	1507	F	MP	3000	MP	37	268	186	32	ND	D	D
										C	--	---	MP	5.4	117	273	D	ND	ND	ND
			232	4	14	1510	4	15	0015	F	MP	250	MP	9.1	D	ND	7.1	ND	D	ND
										C	--	---	MP	2.0	29	56	ND	ND	ND	ND
Lund	27	123	1897	4	14	1745	4	15	1855	F	MP	10,000	--	--	--	--	--	--	--	--
Warm Springs	352	78	1331	4	14	1100	4	15	1400	F	--	BKG	--	ND	ND	ND	ND	ND	D	ND
Queen City Summit (within road-block)	15	39	84.2	4	14	1250	4	14	1540	F	MP	34,000	MP	3220	17,600	19,000	2710	38.4	ND	D
										C	--	---	MP	267	5550	17,800	170	ND	ND	ND
			210	4	14	1540	4	14	2325	F	MP	1000	MP	42	250	ND	27	ND	ND	ND
										C	--	---	MP	22	355	510	ND	ND	ND	ND
Reed (unpopulated)	2	36	252	4	14	0948	4	14	1605	F	MP	5400	MP	118	615	410	100	12.7	ND	D
										C	--	---	MP	4.5	145	408	ND	ND	ND	ND
			250	4	14	1607	4	14	2230	F	MP	800	MP	14.3	82	ND	11.6	ND	D	ND
										C	--	---	MP	9.3	175	240	ND	ND	ND	ND

Table 6 - Concentrations of activity in air sampled by filters and cartridges at off-site locations during the Eel Event.

I. STATION LOCATION			II. COLLECTION DATA							COLLECTOR	III. RADIOASSAY DATA											
				SAMPLING PERIOD							GROSS β COUNT		GAMMA PULSE HEIGHT ANALYSIS								
				BEGIN			END							ACTIVITY (pc/M³)							
STATION NAME	AZIMUTH (°)	DISTANCE (miles)	AIR VOLUME (M3)	Month	Day	Time	Month	Day	Time		CORR. TO:	ACTIVITY (pc/M³)	CORR. TO:	I^{131}	I^{133}	I^{135}	Te^{132}	$Ba-La^{140}$	$Zr-Nb^{95}$	Ru^{103} Ru^{106}	Ce^{141} Ce^{144}
Currant	15	115	939	5	19	0705	5	19	2000	F	MP	3400	MP	15	ND	ND	ND	4.5	D	D	D
			848	5	19	2000	5	20	0645	F	MP	36	--	--	--	--	--	--	--	--	--
										C	--	---	MP	5.6	23	18	ND	ND	ND	ND	ND
Diablo	359	55	207	5	19	0925	5	19	1540	F	--	360	--	--	--	--	--	--	--	--	--
										C	--	---	MP	ND	3.2	12	ND	ND	D	D	D
			669	5	19	1545	5	20	1030	F	--	BKG	--	--	--	--	--	--	--	--	--
										C	--	---	MP	ND	0.69	1.4	ND	ND	D	D	D
Ely	22	158	476	5	19	0900	5	19	1400	F	--	BKG	--	--	--	--	--	--	--	--	--
										C	--	---	--	ND	ND	ND	ND	ND	D	ND	ND
Gunderson's Ranch	15	37	355	5	19	0900	5	19	1635	F	MP	1000	MP	ND	D	18	2.9	ND	D	D	ND
										C	--	---	MP	ND	3.7	8.2	ND	ND	ND	ND	ND
Lund	24	131	338	5	19	1100	5	19	1830	F	--	BKG	--	--	--	--	--	--	--	--	--
										C	--	---	--	ND	D	ND	ND	ND	D	ND	D
Tempiute	24	37	297	5	19	0930	5	19	1630	F	MP	46	--	--	--	--	--	--	--	--	--
										C	--	---	--	ND	D	ND	ND	ND	D	D	D
Twin Springs Ranch	355	74	1428	5	19	0615	5	20	0615	F	--	BKG	--	--	--	--	--	--	--	--	--
										C	--	---	--	ND	ND	ND	ND	ND	D	D	D

Table 7 - Concentrations of activity in air sampled by filters and cartridges at off-site locations during the Des Moines event.

I. STATION LOCATION			II. COLLECTION DATA							COLLECTOR	III. RADIOASSAY DATA									
STATION NAME	AZIMUTH (°)	DISTANCE (miles)	AIR VOLUME (M3)	SAMPLING PERIOD							GROSS β COUNT		GAMMA PULSE HEIGHT ANALYSIS							
				BEGIN			END							ACTIVITY (pc/M³)						
				Month	Day	Time	Month	Day	Time		CORR. TO:	ACTIVITY (pc/M³)	CORR. TO:	I^{131}	I^{133}	I^{135}	Te^{132}	Ba-La^{140}	Ru^{103}	Ru-Rh^{105}
Currant	22	119	212	6	14	0700	6	14	1200	F	MP	880	MP	23	ND	ND	60	ND	13	ND
Diablo	8	50	524	6	13	0840	6	13	1925	F	CP	5900	CP	190	2700	20,000	530	30	38	D
										C	--	---	CP	15	490	2000	26	D	2.9	ND
			1693	6	13	0700	6	14	0700	F	TC	217	--	--	--	--	--	--	--	--
			1612	6	14	0700	6	15	0700	F	TC	26.5	--	--	--	--	--	--	--	--
Eureka	3	159	710	6	13	2000	6	14	1325	F	CP	185	CP	2.6	42	ND	8.6	ND	BKG	D
										C	--	---	CP	0.70	20	ND	1.6	ND	D	ND
Gunderson's Ranch	32	37	265	6	13	1350	6	13	1935	F	CP	470	CP	D	D	D	2.9	ND	BKG	D
										C	--	---	CP	D	12	D	2.1	ND	D	D
Lund	30	130	595	6	13	1900	6	14	1115	F	CP	1100	CP	9.0	ND	ND	18	ND	4.6	ND
										C	--	---	CP	1.4	40	ND	1.7	ND	D	ND
Warm Springs	352	67	258	6	13	1450	6	13	2005	F	--	BKG	--	ND	ND	ND	ND	ND	BKG	ND
										C	--	---	MP	ND	3.2	ND	D	ND	ND	ND
			528	6	13	2012	6	14	0730	F	CP	45	CP	ND	ND	ND	3.3	ND	BKG	D
										C	--	---	CP	D	5.8	ND	1.1	ND	ND	ND
Queen City Summit (on Hwy. 25)	20	39	323	6	13	1410	6	13	1910	F	CP	15000	CP	1300	14,000	220,000	3000	220	280	D
										C	--	---	CP	62	2400	6400	88	10	4.9	D

APPENDIX D

RADIOACTIVITY IN SAMPLES OF WATER AND OF MILK COLLECTED OFF SITE DURING OPERATION NOUGAT

Table No.		Page
Table 1.	Gross beta activity in water samples routinely collected from off-site locations during Operation Nougat.	D-1
Table 2.	Concentrations of various isotopes in milk samples collected off site during Operation Nougat.	D-4

Table 1. Gross beta activity in water samples routinely collected from off-site locations during Operation Nougat.

LOCATION Azimuth and Distance from CP-1	SOURCE	DATE COLLECTED	GROSS β ACTIVITY (pc/l)
Alamo 57°, 57 miles	Well	7-18-61	21
		10-11-61	29
		11-02-61	27
		1-02-62	< 10
		2-22-62	19
		4-19-62	26
		6-04-62	25
		6-30-62	35
Ash Meadows 198°, 41 miles	Covered Spring	10-13-61	15
		11-06-61	30
		2-20-62	12
		3-29-62	14
		5-11-62	< 10
		6-11-62	17
	Pond	10-13-61	16
		11-06-61	33
		2-20-62	36
		5-11-62	17
		6-11-62	17
Beatty 268°, 38 miles	Capped Springs	11 -- 61	18
		12 -- 61	16
		2-20-62	< 10
		3-29-62	19
		5-11-62	< 10
		6-18-62	< 15
Butler Ranch 85°, 59 miles	Open Spring	9-29-61	12
		11-01-61	19
Butler Ranch (cont'd)		1-02-62	< 10
		2-22-62	23
		4-19-62	13
		6-04-62	10
Cactus Springs 143°, 30miles	Well	10-13-61	< 10
		12-04-61	< 10
		2-22-62	26
		4-20-62	26
		6-05-62	< 10
Caliente 59°, 97 miles	Well	10 -- 61	24
		11-02-61	16
		1-03-62	< 10
		2-21-62	14
		4-19-62	34
		6-05-62	10
Crystal Springs 47°, 61 miles	Open Spring	10-11-61	16
		11-02-61	27
		2-20-62	15
		6-30-62	13
Currant 14°, 128 miles	Well	11-01-61	22
		11-29-61	12
		12 -- 61	19
		2-21-62	< 10
		5-09-62	< 10
		6-29-62	< 10
Desert Game Range 132°, 51 miles	Well	10-13-61	39
		11-01-61	21
		12 -- 61	< 10

Table 1. Gross beta activity in water samples routinely collected from off-site locations during Operation Nougat. (cont'd.)

LOCATION Azimuth and Distance from CP-1	SOURCE	DATE COLLECTED	GROSS β ACTIVITY (pc/l)
Desert Game Range (cont'd)	Well	2-20-62	< 10
		4-20-62	< 10
		6-05-62	< 10
	Pond	10-13-61	27
		11-01-61	17
		2-20-62	< 10
		4-20-62	35
		6-05-62	20
Diablo 0°, 69 miles	Well	10-11-61	15
		11-29-61	< 10
		12 -- 61	17
		2-22-62	51
		3-30-62	15
		4-18-62	45
		6-07-62	30
Furnace Creek 232°, 54 miles	Well	3-30-62	24
		5-16-62	40
		6-11-62	13
Goldfield 311°, 84 miles	Well	11 -- 61	25
		12 -- 61	12
		2-21-62	< 10
		3-29-62	< 10
		4-17-62	35
		5-15-62	19
Gunderson's Ranch 18°, 49 miles	Well	10-11-61	41
		11-16-61	35
Hot Creek Pond 353°, 111 miles	Pond	11-29-61	16
		2-22-62	140
		3-30-62	273
Hot Creek Pond (cont'd)	Pond	4-18-62	244
		6-07-62	50
Indian Springs 139°, 32 miles	Well	10-13-61	< 10
		12-04-61	< 10
		4-20-62	< 10
		6-05-62	< 10
Lake Mead 132°, 94 miles	Lake	12-04-61	< 10
		2-22-62	32
		4-19-62	26
		6-07-62	14
Las Vegas 136°, 74 miles	Tap*	10-11-61	13
		12-05-61	< 10
		2-22-62	< 10
		4-20-62	10
		6-05-62	< 10
Lathrop Wells 223°, 27 miles	Well	11-02-61	68
		12-01-61	< 10
		2-20-62	< 10
		3-29-62	17
		5-17-62	49
		6 -- 62	< 10
Lida Junction 304°, 73 miles	Well	11-02-61	18
		11-28-61	21
		12 -- 61	25
		2-20-62	17
		3-29-62	25
		4-17-62	28
		5-15-62	61
Muddy River 102°, 84 miles	River	9-29-61	27
		10-12-61	32
		11-01-61	26

*Water for Las Vegas domestic supply may be from wells or from Lake Mead depending upon demand.

Table 1. Gross beta activity in water samples routinely collected from off-site locations during Operation Nougat (cont'd.)

LOCATION Azimuth and Distance from CP-1	SOURCE	DATE COLLECTED	GROSS β ACTIVITY (pc/l)
Muddy River (cont'd)	River	2-22-62	15
		4-19-62	22
		6-04-62	36
		6-29-62	40
Pahrump 176°, 50 miles	Well	10-13-61	< 10
		11-06-61	16
		1-09-62	< 10
		2-20-62	< 10
		3 -- 62	< 10
		4-04-62	< 10
		5-17-62	19
		6-11-62	10
Rainbow Creek 60°, 95 miles	River	10-12-61	24
		11-02-61	17
		2-21-62	67
		4-18-62	45
		6-05-62	28
Scotty's Junction 297°, 61 miles	Well	3-29-62	15
		4 -- 62	37
		5-15-62	13
Tempiute 23°, 51 miles	Well	11-02-61	11
		1-03-62	< 10
		2-22-62	22
		3-30-62	16
		4-18-62	< 10
Tonopah 322°, 101 miles	Well	11 -- 61	18
		12 -- 61	13
		2-21-62	14
		3-30-62	< 10
		4-18-62	21
		5-16-62	54
Upper Pahranagat Lake 62°, 56 miles	Lake	9-29-61	133
		10-11-61	36
		11-01-61	112
		2-22-62	81
		4-19-62	68
		6-04-62	47
		6-30-62	50
Warm Springs 350°, 89 miles	Well	10-11-61	42
		11-29-61	27
		12 -- 61	35
		2-22-62	45
		3-30-62	43
		4-18-62	20
	Pond	10-11-61	99
		11-29-61	104
		12 -- 61	117
		2-22-62	110
		3-30-62	75
		4-18-62	96
Warm Springs Ranch 101°, 75 miles	Spring	10 61	27
		11-01-61	16
		1-02-62	< 10
		2-22-62	32
		4-19-62	17
		6-04-62	19
		6-30-62	20

Table 2. Concentrations of various isotopes in milk samples collected off site during Operation Nougat.

LOCATION (Az. & Dist. from GZ)	DATE COLLECTED	CONSUMPTION	ACTIVITY pc/l					gm/l	
			Sr^{90}	Sr^{89}	I^{131}	Ba^{140}	Cs^{137}	Ca	K
Adaven 17°, 86 miles	6/20/62	Domestic	10	35	360	< 20	75	1.27	1.3
Austin 344°, 188 miles	6/30/62	Domestic	13	65	180	< 20	75	1.19	1.8
Alamo 57°, 57 miles	12/13/61	Las Vegas	2	10	<10	< 20	<10	1.07	1.7
	2/22/62	Las Vegas	2	< 5	<10	< 20	<10	1.02	1.4
	4/19/62	Las Vegas	3	< 5	<10	< 20	<10	1.16	0.9
	6/04/62	Las Vegas	6	15	<10	< 20	35	1.05	1.4
Battle Mountain 350°, 261 miles	6/28/62	Domestic	21	190	50	< 20	15	1.18	1.9
Blue Eagle Ranch 13°, 105 miles	6/13/62	Domestic	13	60	20	< 20	180	1.28	1.4
Caliente 59°, 97 miles	11/02/61	Domestic	4	< 5	80	30	<10	1.20	1.6
	4/04/62	Domestic	3	5	<10	< 20	<10	1.10	1.3
	6/05/62	Domestic	3	20	<10	< 20	25	1.04	1.5
Carlin 0°, 263 miles	6/22/62	Domestic	9	50	160	< 20	120	1.22	1.1
Diablo Maint. Station 0°, 69 miles	12/01/61	Domestic	3	10	30	< 20	15	1.16	1.5
Elko LDS Stake 5°, 273 miles	6/21/62	Commerical	38	230	610	< 20	200	1.22	1.3
Eureka 1°, 183 miles	6/23/62	Domestic	17	100	110	< 20	100	1.07	1.4
Glendale 111°, 58 miles	11/01/61	Domestic	2	5	65	< 20	<10	1.06	1.3
Hiko 44°, 64 miles	11/02/61	Las Vegas	5	95	720	60	20	1.08	1.4
	12/13/61	Las Vegas	2	< 5	<10	< 20	<10	1.10	1.5
	5/17/62	Las Vegas	1	< 5	<10	< 20	<10	1.14	1.6

Table 2. Concentrations of various isotopes in milk samples collected off site during Operation Nougat. (continued)

LOCATION (Az. & Dist. from GZ	DATE COLLECTED	CONSUMPTION	ACTIVITY pc/l					gm/l	
			Sr^{90}	Sr^{89}	I^{131}	Ba^{140}	Cs^{137}	Ca	K
Las Vegas Anderson Dairy 136°, 72 miles	12/21/61	Las Vegas	3	5	< 10	< 20	< 10	1.12	1.4
Arden Dairy 136°, 72 miles	12/01/61	Las Vegas	2	15	40	80	30	1.02	1.4
	2/13/62	Las Vegas	2	5	< 10	< 20	10	1.00	1.6
Bliss Dairy 136°, 72 miles	12/18/61	Las Vegas	4	5	< 10	< 20	< 10	1.07	1.4
Hinie's Dairy 136°, 72 miles	11/16/61	Las Vegas	3	15	40	< 20	< 10	1.10	1.4
	2/13/62	Las Vegas	2	5	< 10	< 20	< 10	1.04	1.6
LDS Farm 136°, 72 miles	6/05/62	Las Vegas	2	5	< 10	< 20	30	1.09	1.6
Lund 22°, 145 miles	4/25/62	Las Vegas	4	< 5	< 10	< 20	< 10	1.08	1.2
	5/09/62	Las Vegas	1	< 5	< 10	< 20	< 10	1.08	1.6
Panaca 56°, 108 miles	1/03/62	Domestic	2	< 5	< 10	< 20	< 10	1.10	1.6
	4/19/62	Domestic	4	5	< 10	< 20	10	1.14	1.5
	6/04/62	Domestic	2	< 5	< 10	< 20	< 10	1.06	1.6
Robbin's Ranch 21°, 236 miles	6/22/62	Domestic	5	40	520	< 20	140	1.00	1.5
Searle's Ranch 103°, 83 miles	11/01/61	Las Vegas	2	5	70	< 20	< 10	1.06	1.3
	6/05/62	Las Vegas	3	20	< 10	< 20	20	1.04	1.5
Springdale 281°, 38 miles	9/06/61	Domestic	---	---	< 10	< 20	< 10	---	1.3
	2/26/62	Domestic	3	30	< 10	< 20	30	1.01	1.3

Table 2. Concentrations of various isotopes in milk samples collected off site during Operation Nougat. (continued)

LOCATION (Az. & Dist. from GZ	DATE COLLECTED	CONSUMPTION	ACTIVITY pc/l					gm/l	
			Sr90	Sr^{89}	I^{131}	Ba^{140}	Cs^{137}	Ca	K
Springdale (cont'd.)	4/26/62	Domestic	4	25	20	< 20	25	1.08	1.2
	5/28/62	Domestic	8	35	< 10	< 20	50	1.18	1.2
Twin Springs Ranch 357°, 88 miles	11/29/61	Domestic	6	40	90	70	55	1.33	1.3
	4/18/62	Domestic	5	10	< 10	< 20	15	1.18	1.4
	6/08/62	Domestic	8	40	< 10	< 20	70	1.26	1.6
Wells 13°, 299 miles	6/23/62	Domestic	22	135	80	< 20	110	1.22	1.4
Wendover, Utah 21°, 290 miles	6/29/62	Domestic	8	55	90	< 20	25	1.02	2.0
White River Valley 18°, 146 miles	6/13/62	Domestic	15	60	40	< 20	50	1.27	1.5